Manchester Urban Ponds Restoration Program

Year 3 Report
2002

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May 2003

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Appendices

Cover Photo:
Nutts Pond

Acknowledgements

The UPRP would like to thank the following people for their assistance:

Manchester Conservation Commission: Michael Poisson (Chair), Eric Skoglund, Todd Connors, Jen Drociak, JoAnn O'Shaunessy, Kathleen Neville. Special thank you to Cyndy Carlson for her editorial assistance with this report.

Department of Environmental Services: Jody Connor (Limnology Center Director), Andrea LaMoreaux (VLAP Coordinator), Amy Smagula (Exotic Species Coordinator), Steve Landry (Merrimack Watershed Coordinator), Steve Couture (Rivers Program Coordinator), Andy Chapman, Walt Henderson, Ken Warren (Biology Section), Stephanie Lindloff (River Restoration Coordinator). Thank you to the summer interns in the DES Limnology Center who ran the water samples during field season, and to personnel in the Laboratory Services unit at DES who also participated in running water samples.

SEPP Advisory Committee and Associates: Tom Siegle (Manchester Environmental Protection Division), Eric Williams (NHDES), Carl DeLoi (EPA New England), Trish Garrigan (EPA New England), Cyndy Carlson (CDM), Andy Chapman (NHDES).

Black Brook Advisory Committee: Art Grindle (UPRP), Jen Drociak (MCC), Cyndy Carlson (MCC), Kathleen Neville (MCC), Ron Johnson (Manchester Parks & Recreation Department), Joanne McLaughlin (Manchester Highway Department), Stephanie Lindloff (DES), Steve Landry (DES), Andy Chapman (DES), Jim MacCartney (Trout Unlimited), Margaret Watkins (National Park Service)

Urban Ponds Restoration Program: Thank you to Lydia Henry who worked as the Urban Ponds Restoration Program assistant during the summer of 2002. Lydia helped with water quality monitoring, History fact-sheet writing, and assisted with the publication of the annual newsletter.

Thank you to all of our Cleanup Volunteers & Water Quality Monitoring Volunteers!

A Note About This Publication

The text from Section II (Water Quality Analysis of Manchester's Urban Ponds) was taken largely from the Volunteer Lake Assessment Program's bi-annual water quality reports. The associated water quality graphs following analysis are taken directly from these reports. Special thanks to Andrea Lamoreaux (VLAP Coordinator) for use of this information in this report.

Introduction

The Manchester Urban Pond Restoration Program (UPRP) is overseen by the Manchester Conservation Commission (MCC) and is part of a greater environmental effort in Manchester. As part of a solution to address Manchester's combined sewer overflows (CSOs), and improve environmental conditions within the city, six Supplemental Environmental Projects (SEPs) were conceived. These six projects are: Environmental Education Curriculum Development, Children's Environmental Health Risk Reduction, Stormwater Management, Streambank Stabilization, Land Preservation, and the Urban Ponds Restoration Program.

The UPRP was established in 2000 to assess the condition of seven of Manchester's urban ponds (Crystal Lake, Dorrs Pond, Maxwell Pond, McQuesten Pond, Nutts Pond, Pine Island Pond, and Stevens Pond), and to improve their water quality.

The primary goal of the UPRP is to attempt to return the ponds to their historic uses (such as boating, fishing or swimming). Secondly, the UPRP attempts to promote public awareness, education, and stewardship through watershed meetings, clean ups, newsletters, and other educational events. In addidtion, the UPRP aims to reduce pollutant loading and nutrient inputs and improve water quality. The UPRP also tries to maintain or enhance biological diversity. Lastly, the UPRP attempts to provide improved recreational uses at each pond.

Manchester's urban ponds are quite different from one another and face unique challenges posed by the urban landscape that surrounds them. To better understand each pond, the UPRP has gathered baseline water quality data over the past three years, and has identified water quality threats at each pond. The current water quality is described herein, and current projects for the reduction of pollution inputs are also described. Specific solutions to some pond issues include erosion control measures, urban runoff treatment measures, and proper trash disposal. In early 2002, the MCC and UPRP staff developed goals for each pond and a project prioritization plan to help guide future program activities, based upon pond assessments.

In April, 2002 members of the Manchester Conservation Commission met with the Urban Ponds Restoration Coordinator (Art Grindle) to discuss pond "goals" and project "prioritization." Each of the seven ponds was discussed at length with regards to potential water quality improvements, outreach/education opportunities, recreational opportunities, land preservation opportunities, and other management tasks. The result is a clearly defined set of goals and prioritized projects within each of the aforementioned categories. The following conservation commissioners were instrumental in contributing to this project: Jane Beaulieu, Joanne McLaughlin, Michael Poisson, Todd Connors, Eric Skoglund and Cyndy Carlson. This list was recently revised (April 2003) with additional assistance from JoAnn O'Shaughnessy and Kathleen Neville.

For more information on any of these projects, please contact the Urban Ponds Restoration Coordinator at (603) 624-6450 or agrindle@ci.manchester.nh.us.

Section I. UPRP Work Plan & Areas of Focus For 2003-2004

In order to better understand the role of the Program Coordinator, and the Goals of the Urban Ponds Restoration Program (UPRP), the Manchester Conservation Commission (MCC) developed a comprehensive work-strategy in order to better evaluate performance of the Program Coordinator, and measure results based upon goals and objectives set forth in the areas of focus. Since the UPRP is in Year 4 of a 5-year program, the MCC found it important to create such a working document for the future. Below is a result of the collaboration of ideas.

Task I. WORK OBJECTIVES (GENERAL)

1. **Water Quality:** Gain and report a better understanding of water quality in several parameters at each pond.

2. **Outreach/Education:** Promote community awareness/involvement in Manchester's urban ponds.

3. **Restoration Projects:** Develop, initiate, and complete restoration projects at each pond.

4. **Aesthetics/Recreation:** Remove debris from ponds, improve visual appearance of the ponds, work to create/retrofit pond areas as pleasant recreational places.

5. **Partnerships/Visioning:** Establish and work with partners from municipal, state, and federal agencies to ensure program understanding and generate ideas and additional funding.

Task II. JOB DUTIES (SUPPORT WORK OBJECTIVES)

1. **Water Quality:** Continue collecting data and maintaining a database of pond water quality and biological data. Begin analyzing/interpreting/summarizing/reporting data.

2. **Outreach/Education:** Place more emphasis on outreach/education for the next two years. Enlist help of conservation commissioners and existing environmental groups in town as necessary.

3. **Restoration Projects:** Prioritize and balance pond restoration projects for each pond in three categories: Water Quality Improvement, Outreach/Education, and Recreation. Use MCC table to prioritize/report/plan projects.

4. **Aesthetics/Recreation:** Hold bi-annual pond cleanups, assist Parks & Recreation with conceptual trail work & kiosk construction/retrofit, assist with other activities at each pond.

6. **Partnerships/Visioning:** Work closely with the MCC, Planning Department, Manchester Environmental Protection Department (EPD, under Highway Department), SEPP Advisory Committee, and other state and federal officials.

Task III. KEY ASSIGNMENTS (SPECIFIC)

1. **Water Quality**
   - Continue sampling each pond on a regular basis (at least once a month April-October).
   - Seek out other opportunities for more advanced chemical, biological sampling/surveying (i.e. additional sediment depth sampling, macroinvertebrate sampling, fish surveys, bird surveys, etc).
   - Continue systematically adding data into database and interpreting data.

- Summarize and report data and trends in a meaningful way so
  - the stake holders (including MCC, SEPP and public) can understand and take any appropriate action.
  - restoration projects at the ponds are properly prioritized and carried out
  - summarized data is available for "measurable results" type documents, sampling data and cleanup volumes.

2. **Outreach/Education**

- Find new and innovative ways to get information out to the public.
- Coordinate a core group of volunteers for pond cleanups and water quality sampling.
- Give presentations at local middle schools, high schools, colleges, and other groups
- Hold other pond activities/events.
- Produce a bi-annual newsletter (Late Spring, Early Fall)
- Create additional fact-sheets for public dissemination.
- Create and update website.
- Create and distribute annual report.
- Keep kiosk materials current.
- Work more closely with media (Union Leader, Hippo Press, WMUR, etc).

3. **Restoration Projects**

- Prioritize and balance pond restoration projects for each pond in three categories: Water Quality Improvement, Outreach/Education, and Recreation.
- Utilize "Pond Project Prioritization" document created with Manchester Conservation Commission in January 2002 as a guideline document.
- Solicit input from municipal, state, federal agencies and well as the public.
- Publicize efforts and accomplishments (pond projects, grant monies received, etc).
- Forward communications from CEI (design consultant) and DES relevant to the ponds to MCC & EPD, to help keep both groups better informed of progress. This assignment will evolve over the year.

5. **Aesthetics/Recreation**

- Continue holding cleanups, trailwork, and other events at each pond.
- Track volumes of trash collected at each pond. Keep good records of volunteers attending and volume/type of trash collected, i.e. 3 bags of trash (mostly paper), 2 tires and 1 refrigerator. Also track partners, i.e. trash pickup by City.
- Publicize cleanups and other events via e-mail distribution list, newsletter, website, press releases, flyers at kiosks, etc.

6. **Partnerships/Visioning**

- Submit weekly progress reports to MCC (CC: EPD) including major weekly activities for Art and any co-op, meetings (attendees and topics), sampling, cleanups, etc.
- Progress report should also include HELP NEEDED section, which should be a list of things that Art needs advice, help, etc. currently or upcoming.
- Attend information-sharing and collaborative/brainstorming meetings with key partners (Conservation Commission, Environmental Protection Division, Planning Department, SEPP Advisory Committee, Department of Environmental Services, etc)
- Attend SEPP Advisory Committee meetings and Conservation Commission meetings with program updates, items for action, and needed assistance.

- Brainstorm innovative ideas for outreach/education, and new projects.
- Keep Conservation Commission informed of weekly schedule (especially during Summer).
- Create tentative summer sampling/activity schedule and distribute to Conservation Commission.
- Create annual scope, in conjunction with MCC, with activities planned for each month. Include activities completed in weekly update.
- Meet with direct supervision at least twice per month with the goal of meeting more often.
- Meet with other Conservation Commission supervisors more frequently/regularly and utilize their skills/experience when needed.
- Attend Planning Board staff meetings with program updates and keep Planning Board administrative assistants aware of your schedule.
- Distribute important documents (ie, outreach/education, newsletters, reports, etc) to Conservation Commission for review.

Section II. Outreach & Education Endeavors

2002 was an instrumental year for the "reassessment" of goals of the Urban Ponds Restoration Program (UPRP). The beginning of the year brought all conservation commissioners together to systematically diagram the goal(s) for each of the ponds, and include tasks regarding water quality improvement, recreation, and outreach/education. This "prioritized" list led to a more concentrated outreach effort than the previous two years. Since the UPRP is at its "half-way" point, the effort is underway to ensure proper understanding of the issues at each pond, and to instill environmental stewardship in Manchester's residents, now and for years to come. The following items are tasks of the outreach/education portion of the UPRP. Some have been in place since the programs inception – others were added during the last year. In addition, where more of an effort is needed and new ideas have been brainstormed for 2003, these have been included under each task.

Visit http://www.ci.manchester.nh.us/UrbanPonds for more information on any of these programs.

Mailing List Management

The UPRP has sorted through the spreadsheet/mailing list, has updated as needed, and has formed an e-mail "distribution" list. The UPRP plans to utilize this list for future endeavors such as pond cleanups, volunteer opportunities and other events. If you wish to be added to this mailing list, please contact Art Grindle at 603-625-6450 or agrindle@ci.manchester.nh.us.

Clean-Ups/Trash Removal

The UPRP held annual volunteer pond clean-ups at each of the ponds during 2000 and 2001. These were approximately two or three hours in length on a Saturday. In 2002, the UPRP decided to hold bi-annual pond cleanups (once during late spring, and once during late summer/early fall) since an "annual" cleanup was not sufficient to remove all items of trash and keep the areas clean throughout the year. Flyers were posted around town, and pond clean-ups were held on the following Saturdays:

- **April 20 (Nutts Pond):** Six participants.
- **April 27 (Stevens Pond):** Six participants.
- **May 4 (Dorrs Pond):** Five participants.
- **May 11 (Maxwell Pond):** Eight participants.
- **June 1 (McQuesten Pond):** Two participants.
- **September 21 (Maxwell Pond):** Two participants.
- **September 28 (McQuesten Pond):** Two participants.
- **October 5 (Stevens Pond):** Four participants.
- **October 12 (Nutts Pond):** This event was rained out and was not re-scheduled.

The number of participants at all events totaled 35 individuals, with only six outside "citizens." The numbers were much less than expected, even though a great deal of effort went into publicizing the events. To increase participation, in 2003 the clean-ups will be advertised in the UPRP newsletter, *"Pond Possibilities,"* on the UPRP website, and via an e-mail "distribution list." Posters will also continue to be distributed to the city public libraries, local colleges, and pond kiosks.

"Pond Day" Aka "Manchester Earth & Pond Festival

The Manchester Earth & Pond Festival was held on Saturday June 22, 2002 and had approximately 200 participants - a good turnout given the weather that day. The event was scheduled from 10:00-3:00pm but was rained out at approximately 1:00pm. Many groups had display tables, including the UPRP, USGS, Doors Pond Preservation Society, Crystal Lake Preservation Association, Manchester Health Department, Manchester Recycling Program and Amoskeag Fishways. US Senator Bob Smith made an appearance, and the event was covered in both the Union Leader and the Hippo Press.

A "trail walk" around Dorrs Pond including tree/shrub identification, wetland functions/values, nonpoint source/stormwater runoff issues, was led by Conservation Commissioners Jen Drociak and Eric Skoglund.

Pond Project Prioritization

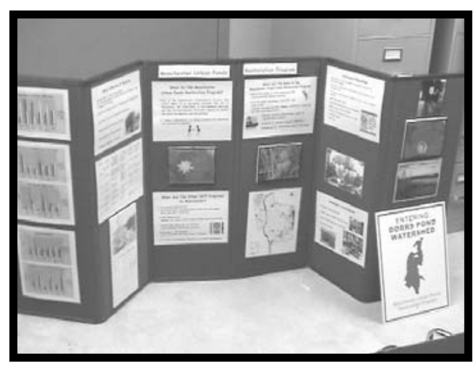
During the winter 2002, the Conservation Commission held "working" meetings to prioritize projects at each pond. As described in Section I, the Commission met three times and came up with a goal for each pond, and listed projects for water quality improvements, recreational opportunities, outreach/education endeavors, and other projects. These meetings were highly successful because now the Conservation Commission and UPRP has a detailed "prioritized" working list of projects for each pond, and approximate costs and timetables attached to each.

Presentation Design & Presentations

In 2002, Jen Drociak created a "Powerpoint" presentation for the UPRP. This presentation includes an overview of "SEPP", the goals of the UPRP, definitions, water quality collection and analysis, outreach/education endeavors, and specific projects at each pond (water quality, recreational, outreach/educational). The presentation also includes a "virtual" tour of each pond. On December 15th, 2002 Jen Drociak gave a presentation on the UPRP to an Ecology class at Springfield College, Manchester NH. Jen and Art plan to use the presentation for classes at UNH Manchester, St. Anselms College, and Southern NH University. They hope this will generate additional volunteers for the program.

Display Design & Outreach/Education Endeavors Binder

In 2002 Jen Drociak created a display which closely mirrored the UPRP Powerpoint presentation. The current display is in full color and is laminated. In 2003, the UPRP will use it as a "traveling" display and station it at places such as City Hall, Manchester City Library (east and west), and local colleges for one to two week intervals during the year. The display includes copies of the Year One and Year Two reports, copies of the SEPP brochure, the UPRP brochure, and a newly created "Outreach/Education Endeavors" binder. This binder pulls together all UPRP maps, posters, flyers, brochures, fact-sheets, newspaper articles, photos, and inventories that have been created to date.



Fact-Sheet Writing & Design

Jen Drociak created pond-specific posters for each pond titled *"Common Exotic Plants"* and *"Common Fish."* All of these posters are in 11x17 format, color, and feature photographs and descriptions of the resident plants and fish. She also created fact-sheets for *"Common Reed"*, *"Glyphosate"* (to be distributed to Crystal Lake abutters during a 2003 *Phragmites* removal endeavor) and *"Yard Waste."* These posters will be displayed at the pond kiosks to inform residents of how they affect water quality in the ponds with everyday actions. These posters are collected in Appendix A.

In addition, Lydia Henry, the 2002 summer intern created *"History Of"* fact sheets for each of the ponds. For each pond's kiosk, the UPRP hopes to have all fact-sheets (including water quality graphs and EPA stormwater posters) laminated and displayed by Summer 2003 (pending creation/modification of kiosks).

Herbarium

During the summer of 2002 Jen Drociak collected, pressed, and mounted over 80 wetland plant species including emergent, submerged, and floating plants. Each plant is labeled with common name, Latin name, location of specimen, and collected by. The UPRP hopes to continue this and use these for presentations and education.

"Meet Your Pond" Days/Trail Walks

During the summer of 2002 the UPRP had three "Meet Your Pond" days

- **Saturday July 13 (Dorrs Pond):** Three participants.
- **Thursday July 18 (Nutts Pond):** Three participants.
- **Saturday August 3 (Maxwell Pond):** Three participants.

Though there was a disappointing turnout at each, the focus was to conduct trail walks, discuss the history of the waterbody, and future projects. An overview of water quality sampling equipment, and tree/shrub identification were also included in the walk. To increase participation, in 2003 the "Meet Your Pond" days will be advertised as "Trail Walks" in the UPRP newsletter, *"Pond Possibilities,"* on the UPRP website, and via an e-mail "distribution list." Posters will also continue to be distributed to the city public libraries, local colleges, and pond kiosks.

Newsletter *"Pond Possibilities"*

The newsletter "Pond Possibilities" has been an annual distribution detailing the activities ongoing through the UPRP. For 2003, the newsletter will be distributed twice a year instead of once. One issue will be sent out late spring/early summer (including spring/summer volunteer and other events), and the other will be sent out late summer/early autumn (including autumn/winter volunteer and other events and would re-cap summer activities). The newsletter is distributed to approximately 250 people citywide.

Newspaper Article Writing

The UPRP has sent several articles, press releases, photos, and event listings to the Union Leader and the Hippo Press newspapers. These are included in Appendix B.

Surveys (UPRP & Nutts Pond Business)

During the fall of 2002 the UPRP created a watershed survey. The survey was designed to provide a better understanding of the public awareness level of the environmental conditions of Manchester' urban ponds.

2,000 random surveys were distributed. The survey participants were chosen at random from the Manchester registered voter list. It was hoped that 400-500 (20-25%) of the surveys will be returned. The surveys were mailed out mid-late January 2003. The participants were given two weeks to return the survey (to UNH). Out of the 2,000 distributed, those that did not send back the survey were sent a duplicate survey (from the UPRP) and given an additional two weeks to respond (to UNH). Out of those people who did not respond, a reminder postcard was sent (from the UPRP). The entire process took approximately 6 weeks. The UNH Survey Center compiled the data and sent back qualitative/quantitative survey results. The survey will be repeated in one year, to determine awareness of the UPRP and its ponds, and any measurements from our outreach/education endeavors during the next year. These surveys will go to the same people that received the original survey). In addition, "ballot" type boxes and surveys (a different color to differentiate) where left at public places such as the public libraries, City Hall, and other places.

The UPRP also created a "pollution prevention" nonpoint source business survey for facilities within the Nutts Pond watershed. The on-site assessments will be performed throughout summer of 2003. A few weeks prior to the on-site visits, the businesses will be mailed a letter explaining the project, with a list of "topics" and/or some questions. During the on-site visits, the store manager or facilities maintenance person will be requested for assistance. Myself, along with the Program coordinator (or an intern) will compile the data and create a document/web page on the results.

Watershed Signs

In November 2002, Art Grindle and Jen Drociak posted the first signs, and coordinated a "press event" to commemorate our achievements. We did so and the Mayor, several City Departments, Conservation Commissioners, and the Union Leader attended the event on DW Highway near Dorrs Pond. Approximately 30 signs will be posted around the city during the spring of 2003.

Website Design

During the Fall of 2002, Art Grindle, Jen Drociak, and Cyndy Carlson developed/compiled the content for a 25-page UPRP website including 55 PDFs, several photos, links to outside sources, etc. The site has a "home" page, a "goals" page, a link to the EPD SEPP pages, biological and water quality monitoring page, volunteer opportunities page, schedule of events, publications, and 7 pond-specific pages including a watershed map, water quality tables, vegetation inventory, fish tissue analysis, sediment sample analysis, current and future projects, and fact-sheets. Visit http://www.ci.manchester.nh.us/UrbanPonds for more information!

Section II. Water Quality Monitoring

Sampling Procedures & Laboratory Analysis Costs

The UPRP conducted water sampling at Manchester's seven urban ponds from April through October of 2002. This marked the third year of baseline water quality data collection at each pond. Water quality monitoring parameters included temperature, dissolved oxygen, pH, acid neutralizing capacity, conductivity, total phosphorus, chlorophyll_*a* abundance, Secchi disk transparency, and turbidity. A brief explanation of each parameter follows. Table 1 compares the measured parameters in Manchester ponds to a "typical" NH lake.

Due to occasional equipment difficulties, and conflicting schedules, data gaps do exist. Given the different circumstances at each pond, the numbers representing the various parameters may not reflect that pond's water quality condition relative to any other of the ponds studied.

The Department of Environmental Services' (DES) Volunteer Lake Assessment Program (VLAP) sampling procedure was used as a template for these sampling sessions. VLAP also created annual water quality reports for each pond and can be viewed by visiting http://www.des.state.nh.us/wmb/vlap/. The detailed procedure for collecting water samples is included in Appendix D. All water sample analyses (except Total Phosphorus) were performed at the DES Limnology Center in Concord, NH, by DES personnel *. Total Phosphorus was analyzed by DES Laboratory Services. The raw water quality data is included in Appendix E.

In 2003, the DES Limnology Center analyzed 283 water samples free of charge. The UPRP thanks DES for this leveraging of, which would have totaled **$2,608.00** worth of services.

Parameter	**Number of Samples**	**Cost Per Sample**	**Total Cost**
Conductivity	99	$6.00	$594.00
Chlorophyll_*a*	24	$20.00	$480.00
pH	32	$6.00	$192.00
ANC	31	$12.00	$372.00
Turbidity	97	$10.00	$970.00
			$2,608.00

Table 1

Comparison of "Typical" New Hampshire Lake Values[1] to Manchester Pond Values[2]

2002 Sampling Season

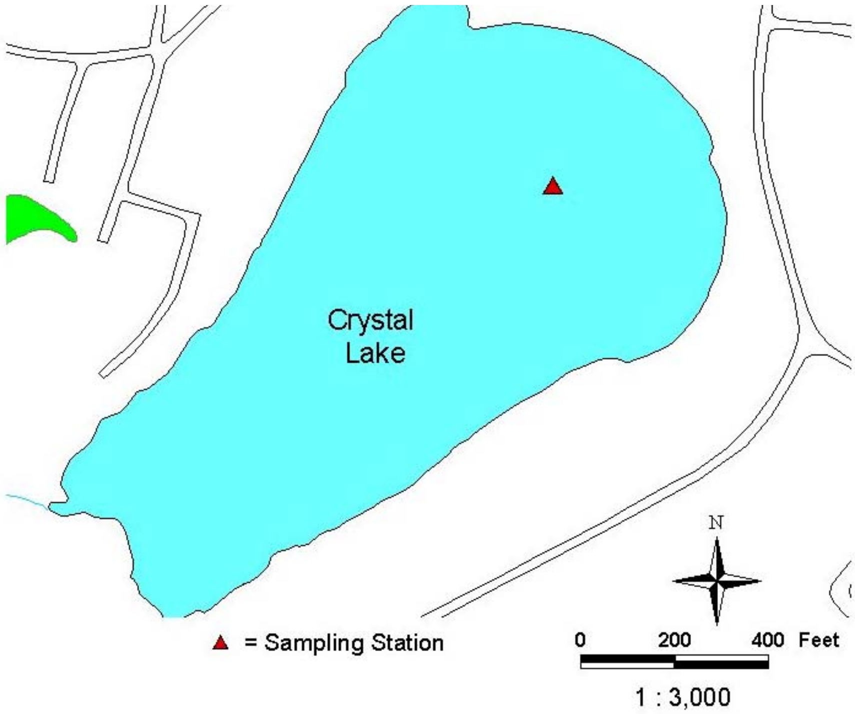
Parameter	# of Lake Stations	Typical NH Lake		Crystal Lake		Dorr s Pond		Maxwell Pond		Nutts Pond		Pine Island Pond		Stevens Pond	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
pH	780	6.5	6.6	7.07	7.07	7.12	7.15	6.50	6.52	6.77	6.77	6.86	6.93	7.03	7.07
Alkalinity	781	6.6	4.9	20.2	17.7	26.5	26.5	6.7	3.6	15.4	15.4	21.2	24.5	30.8	17.7
Total Phosphorus	772		.012	.012	.015	.021	.021	.015	.016	.024	.024	.023	.026	.018	.015
Conductivity	768	59.4	40.0	443.8	442.5	882.6	899.0	201.4	147.8	580.4	546.0	316.1	357.5	1102.0	442.5
Secchi Disk	663	3.7	3.2	3.9	4.2	2.0	2.05	>1.1	>1.1	2.9	2.9	1.9	2.0	2.9	4.2
Chlorophyll*a*	776	716	4.58	2.64	2.64	8.40	8.72	1.68	1.68	10.81	7.73	8.23	738	3.20	2.64

1) "Typical" values are summer epilimnetic values from DES VLAP. 2) Manchester Pond Values are epilimnetic median and mean values. * Estabrook, R. 2001. NH DES. Water Division.

Section IV.
Water Quality Analysis of Manchester’s Urban Ponds

Crystal Lake

Figure 4: Crystal Lake Sampling Stations



Pond Location and Description

Stevens Pond is the only swimmable pond in Manchester. Located off of Corning Road in South Manchester, it has a very popular beach. The goals and projects designed for this water body therefore reflect the pond's important recreational uses.

Pond Goals & Project Status

Goal(s): To maintain fishable and swimmable water quality standards

Water Quality:

1) Address beach parking lot runoff/drainage issues.
2) Address Corning Rd runoff/drainage issues.

The health of Crystal Lake has been the focus of the efforts of the Crystal Lake Preservation Association (CLPA) since their inception in 1994. In 1999, the CLPA was awarded a grant from DES to install a new stormwater treatment system – the StormTreat system. This system now treats runoff from Bodwell Road and adjacent parking areas before it enters the lake. With this installation, one of only three surface water inlets is now being treated.

During the fall of 2002, an environmental engineering firm, Comprehensive Environmental, Inc (CEI) was contracted through the SEPP to design plans to address items 1 & 2 above. The final design plans are now complete and are in the process of going out to bid for a contractor. These projects will include installation of best management practices (BMPs) at the two remaining outfalls that impact Crystal Lake. These outfalls contribute large amounts of sediment and nutrients to the lake during every rainfall. A series of catch basins drain the access road and parking area of the public beach and are connected to a culvert that outfalls at the north end of the beach. A sediment delta has developed here over the years. Preliminary plans have been designed to stabilize the shoulders of the access road with crushed stone and installation of proper drainage. Drainage of the parking area will also be improved. A grassed swale will be installed north of the parking area to treat the remaining runoff from the parking area.

The outfall that drains part of Corning Road is directly adjacent to a highly erodable steep slope. The slope contributes sediment that washes down Corning Road and into the drainage system. The slope also results in the necessity for intensive salt/sand treatment during winter months because of the high occurrence of icing on this section of road. These combined factors have formed a nutrient-rich sediment delta in the Lake at the point of the outfall.

At this location, a velocity-reducing device coupled with an infiltration gallery is proposed. Due to the steep slope of the area between Corning Road and the shoreline, a baffle tank is called for at the top of the drainage line. The two-baffle system will allow sediment to settle before flows continue down the line to the infiltration gallery. Installation of curbing along the south side of Corning Road will help prevent sediment eroding from the steep hillside from entering the drainage system.

3) Address *Phragmites* stand by chemical and mechanical treatments.

SWAMP Inc, has been contacted to submit an application to the Department of Agriculture, pesticide board to spray Glyphosate (*Rodeo*) on the area late in the growing season of 2003. The stalks from the dead plants will be cut above the ice during the winter and hauled away. Any remaining plants that survive during the growing season of 2004 will be sprayed and cut again. The UPRP has drafted an abutter letter explaining the herbicide application, and has also created a fact-sheet on *Phragmites* as well as Glyphosate to include in the abutter mailing.

Outreach/Education:

1) Continue providing educational materials in kiosk at beach.

A series of color, laminated fact-sheets and posters has been created to be posted in the kiosks during the summer of 2003. These include a map of the waterbody/watershed, fact-sheets for water quality results, the history of the waterbody, and non-point source pollution issues, and posters on common exotic plants and common fish.

2) Conduct native planting workshop to address intensely-maintained shoreland areas.

3) Provide *Phragmites* education to property owners.
4) Provide Milfoil prevention education to property owners.

Items 3 & 4 will be completed during an abutter mailing during the summer of 2003.

Recreational:

1) Support project partner efforts to preserve and restore beach house and address parking situation.

The Crystal Lake Preservation Association (CLPA) and For Manchester are working to address improvements to the beach house.

Land Preservation:

1) Support the advocacy of land conservation in areas where there is development pressure.
2) Provide careful consideration of land acquisition within the watershed.

CLPA has also been active in attempts to preserve certain tracks of land adjacent to the lake that are threatened by residential development. This area, known as the Filip's Glen subdivision, is the only remaining open space in proximity to the lake. It is important for the long-term health of the lake that this area be developed only in the most environmentally sensitive way possible. Plans are currently in place to purchase a portion of the property proposed for development. The developer has donated the largest wetland portion of the property to the CLPA. This particular portion is the closest to the lake of all the properties in question. A significant amount of the Urban Ponds Restoration Program budget has been allocated for the ultimate purchase and preservation of large portions of the Filip's Glen subdivision property to help preserve the water quality of Crystal Lake.

Other:

1) Create Watershed Management Plan

Water Quality

Chlorophyll-*a*

Composite values for chlorophyll-*a* for the upper 3 meters ranged from 2.16 to 3.13 milligrams/cubic meter (mg/m^3), with a median of 2.64 mg/m^3.

The current year data (the top graph) show that the chlorophyll-a concentration decreased by a large amount from May to July, and then decreased slightly from July to September, and then increased slightly from September to October. The chlorophyll-a concentration was much greater than the state mean in May, and was much less than the state mean on the other sampling events. The elevated chlorophyll-concentration in May is possibly due to a spring diatom bloom (large growth of diatom algae). The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is approximately equal to the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has not significantly changed (either increased or decreased) since monitoring began in 1993. Specifically, the chlorophyll-a concentration has fluctuated, but has not continually increased or decreased since monitoring began.

While algae are naturally present in all lakes/ponds, an excessive or increasing amount of any type is not welcome. In New Hampshire's freshwater lakes/ponds, phosphorus is the limiting nutrient that algae depend upon for growth. Therefore, algal concentrations may increase when there is an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). It is important to continually educate residents about how activities within the watershed can affect phosphorus loading and lake quality, i.e. excessive lawn fertilization and unmanaged pet wastes.

Conductivity

Conductivity in the epilimnion (top layers) ranged from 424 to 466 uMhos/cm, with an average of 443.8 uMhos/cm. The conductivity has increased in the lake since monitoring began.

Dissolved Oxygen

The dissolved oxygen concentration was low in the hypolimnion (bottom layers) at the deep spot of the lake on the July, September, and October sampling events. As stratified lakes age, oxygen becomes depleted in the hypolimnion. In addition, depleted oxygen concentration in the hypolimnion of thermally stratified lakes (cold bottom layer, warmer top layer) typically occurs as the summer progresses. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion the phosphorus that is normally bound up in the sediment may be re-released into the water column

pH and Acid Neutralizing Capacity

The mean pH at the deep spot this season ranged from 6.90 in the hypolimnion to 7.14 in the epilimnion, which means that the water column ranges from being slightly acidic near the bottom of the lake to being slightly basic (meaning alkaline) near the surface.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continues to remain high (16.73 mg/L as $CaCO_3$) and is much greater the state mean of 6.7 mg/L (Table 5). Specifically, this means that the lake/pond has a “low vulnerability” to acidic inputs (such as acid precipitation)

Phosphorus

The total phosphorus concentration (TP) measured in the epilimnion of Crystal Lake ranged from 0.008 to 0.015 mg/L, with a mean of 0.012 mg/L.

The current year data for the epilimnion (the top inset graph) show that the total phosphorus concentration increased from May to July, remained stable from July to September, and then decreased from September to October. The total phosphorus concentration in July and September was greater than the state median.

The historical data show that the 2002 mean epilimnetic total phosphorus concentration is slightly greater than the state mean.

The current year data for the hypolimnion (the bottom inset graph) show that the total phosphorus concentration increased gradually from May to September. The total phosphorus concentration in July was approximately equal to the state median, while the concentration in September was greater than the state median.

The historical data show that the 2002 mean hypolimnetic total phosphorus concentration is approximately equal to the state mean.

Overall, the statistical analysis of the historical data show that the total phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has not significantly changed (either increased or decreased) since monitoring began in 1993. Specifically, the total phosphorus concentration in the epilimnion and hypolimnion has varied (meaning fluctuated), but has not continually increased or decreased since monitoring began.

Transparency

Secchi disk transparency ranged from 1.25 to 5.9 meters, with a median of 4.2.

The current year data (the top graph) show that the in-lake transparency gradually increased from May to October this season. The transparency in May was much less than the state mean. In July, September, and October the transparency was greater than the state mean.

It is important to note that the transparency in May was the lowest observed this season, while the chlorophyll-a concentration on the May sampling event was the greatest concentration measured this season. We generally expect this inverse relationship between chlorophyll-a and transparency in lakes. As the amount of algal cells in the water column increases, the transparency typically decreases.

The historical data (the bottom graph) show that the 2002 mean transparency is slightly greater than the state mean.

Overall, the statistical analysis of the historical data (the bottom graph) show that the mean annual in-lake transparency has not significantly changed (either increased or decreased) since monitoring began in 1993. Specifically, the in-lake transparency has remained relatively stable and has ranged between approximately 3.5 to 4.5 meters.

Turbidity

Turbidity in Crystal Lake ranged from 1.05 to 4.56 with an average of 2.21 (NTU). Turbidity levels in the epilimnion of Crystal Lake have doubled each year since 2000.

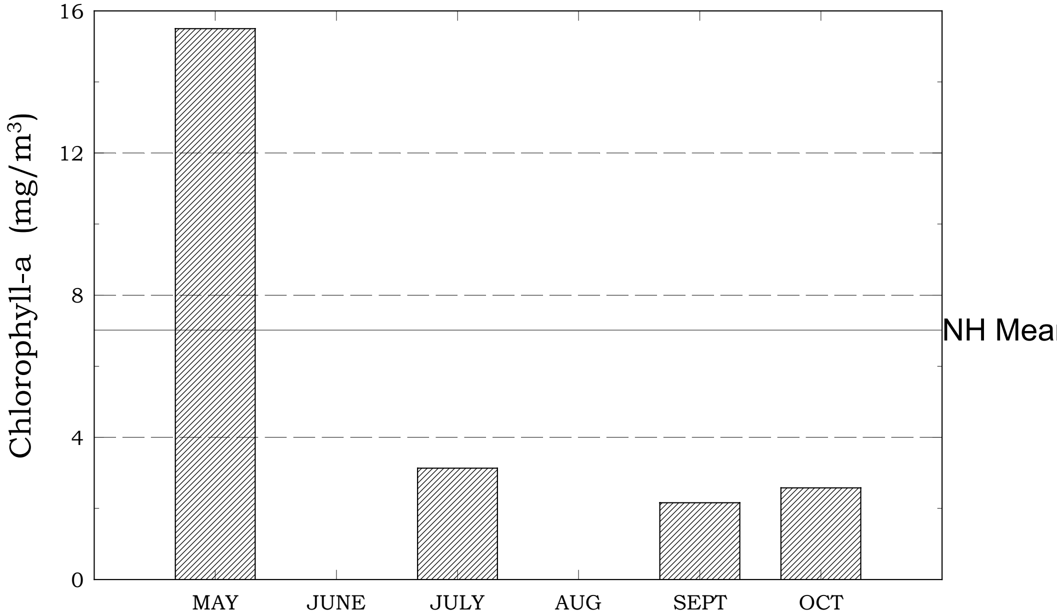
Table 2[1]
Comparison of Crystal Lake – 1981*, 1985, 1997+ & 2000 – 2002**

Parameter	7/14/81	1985 Median	6/30/97	2000 Mean	2000 Median	2001 Mean	2001 Median	2002 Mean	2002 Median
pH	7.3	7.2	7.1	6.99	6.94	7.09	7.09	7.07	7.07
Alkalinity (mg/l)	21.9	20.8	16.1	18.1	18.8	17.3	16.0	20.2	17.7
Total Phosphorus (mg/l)	0.043	0.02	0.019	0.011	0.011	0.012	0.012	0.012	0.013
Conductivity (uMhos/cm)	317	316	342	418.7	418.0	439.7	444.0	443.8	442.5
Secchi Disk (m)	2.0	3.0	4.5	4.3	4.5	3.5	3.5	3.9	4.2
Chlorophyll-*a* (mg/m3)		22.17		3.39	2.72	4.75	5.10	2.64	2.64

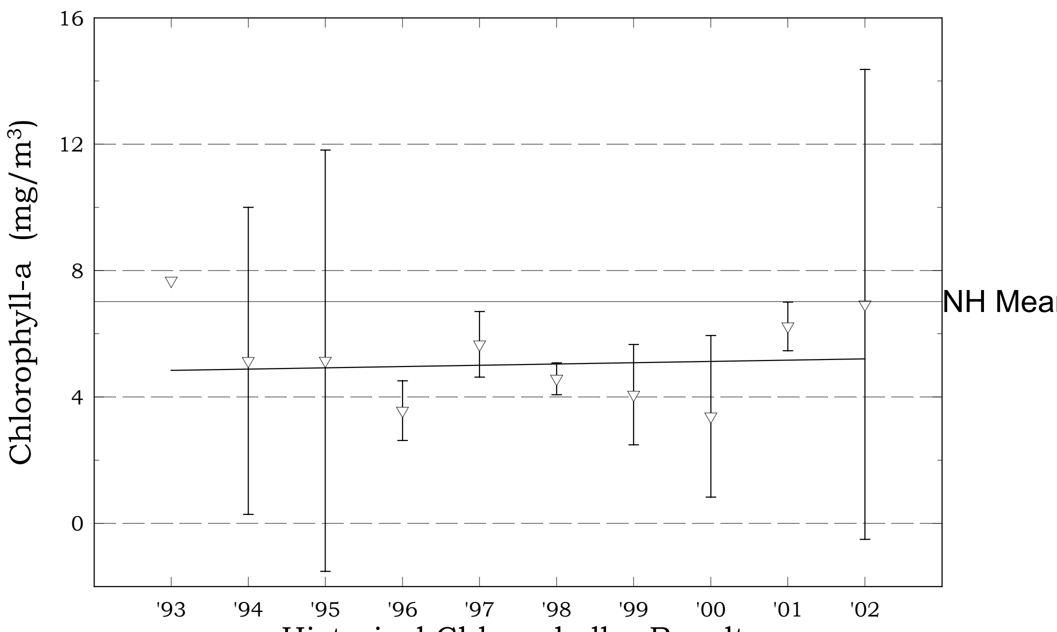
1) All values are epilimnetic values, except chlorophyll-*a* which is a composite of measurements taken at several depths.
* NH Dept. of Environmental Services. 1981. Trophic Classification of NH Lakes and Ponds.
** Estabrook, R., et al. 1985. Urban Lakes Diagnostic/Feasibility Study. Staff Report No. 140. New Hampshire Water Supply and Pollution Control Commission.
+ NH Dept. of Environmental Services. 1998. Lake Trophic Data.

Crystal Lake, Manchester

Figure 1. Monthly and Historical Chlorophyll-a Results



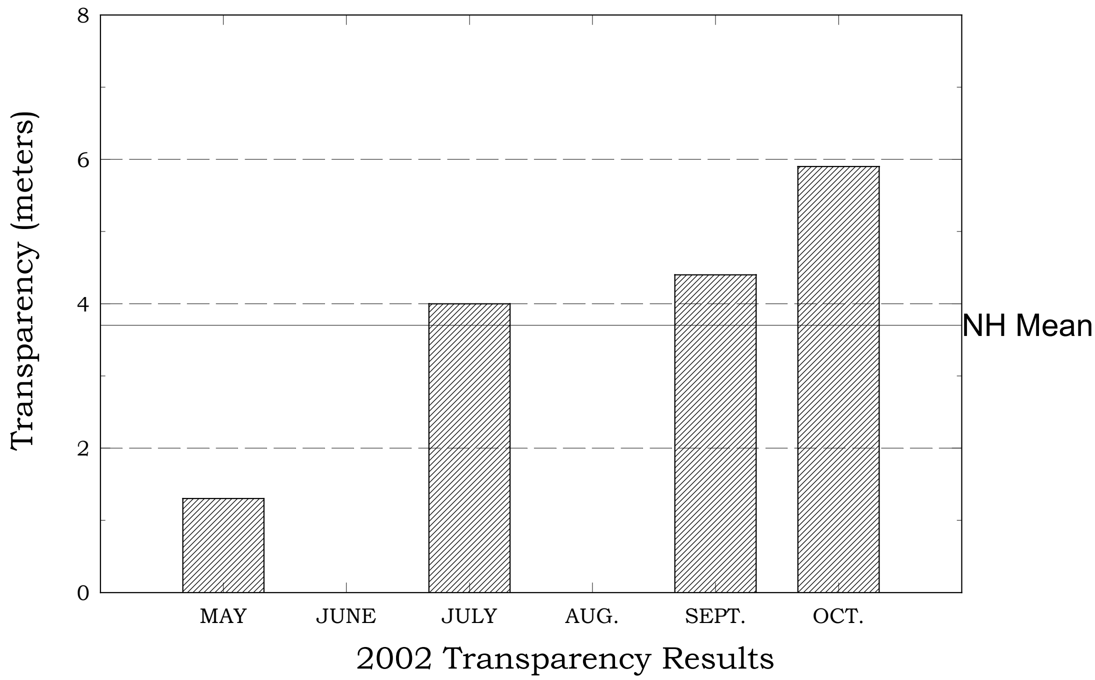
2002 Chlorophyll-a Results

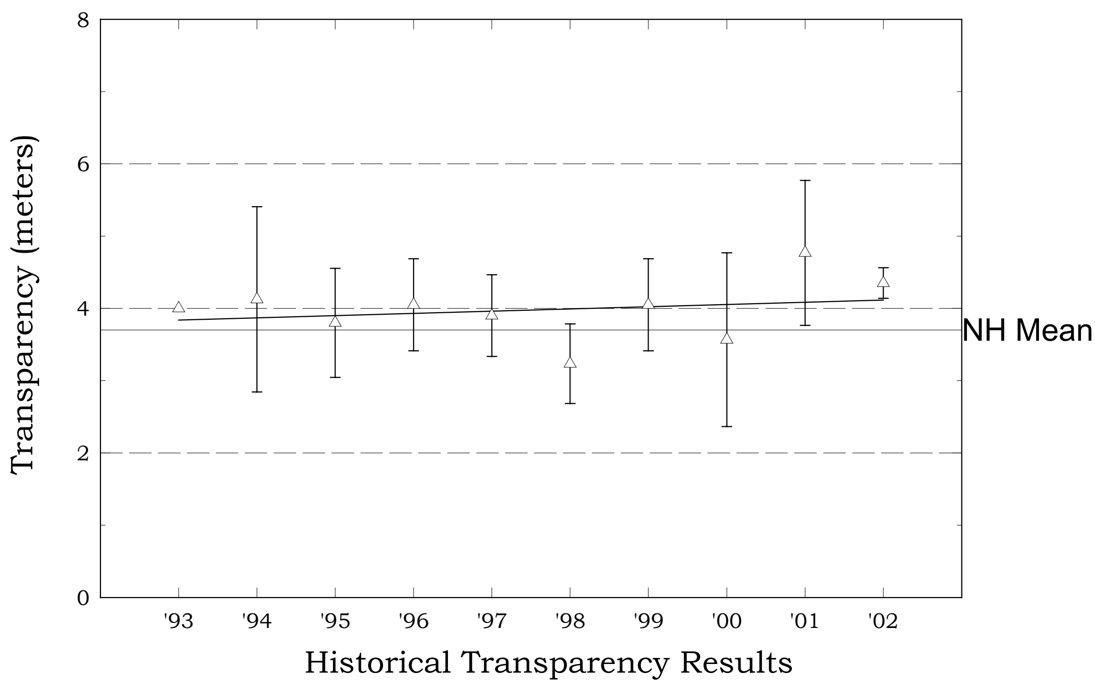


Historical Chlorophyll-a Results

Crystal Lake, Manchester

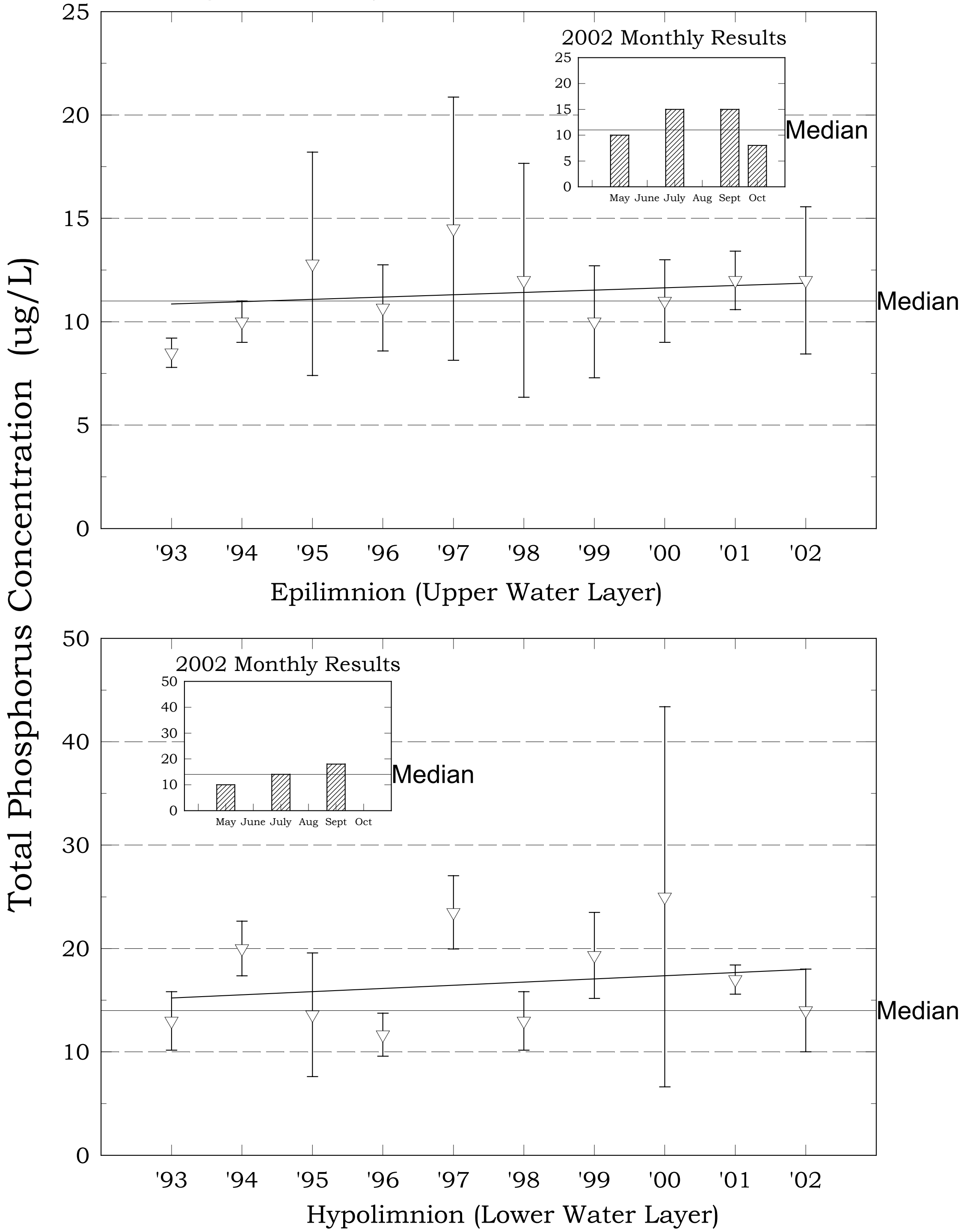
Figure 2. Monthly and Historical Transparency Results





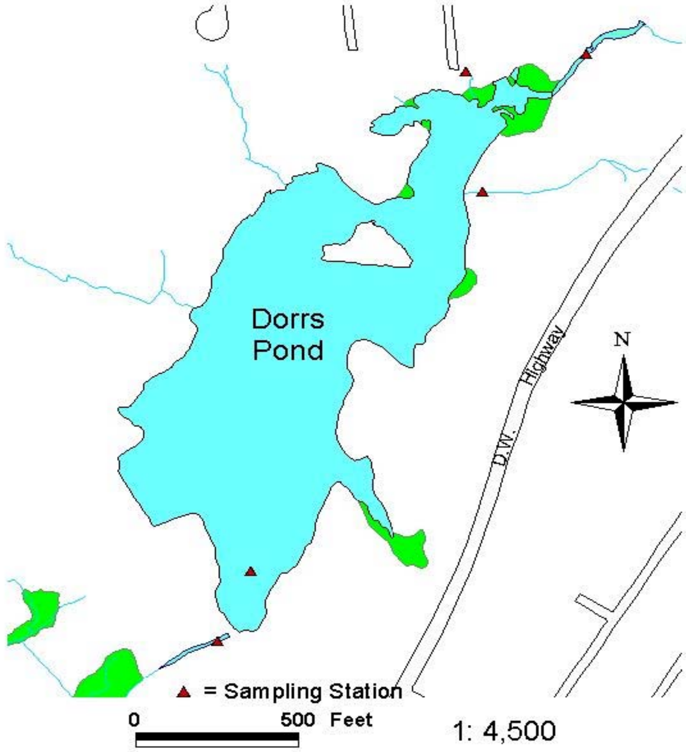
Crystal Lake, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.



Dorrs Pond

Figure 4 – Dorrs Pond Sampling Stations



Pond Location and Description

Dorrs Pond is a very important recreation location in Manchester. A trail system circles the pond and a pool, playground and ball fields abut it. Fishing and ice skating are two other common recreational activities here. The goals and projects designed for this water body therefore reflect the pond's recreational uses.

Pond Goals & Project Status

Goal(s): To restore fishable and swimmable water quality standards.

Water Quality:

1) Address tributary 2E (shown in Figure) runoff/drainage improvements.
2) Address tributary DP3 (shown in Figure) runoff/drainage improvements.

In 1997 the Dorrs Pond Preservation Society (DPPS) was awarded a Section 319 local watershed initiative grant from NH DES to perform stormwater improvements on the main tributary to the pond (DP3). In December 2001, a Downstream Defender was installed to catch runoff from Northside Plaza, and separate sediment and floatables before entering the main tributary to Dorrs Pond. Through a collaborative effort, the Manchester Highway Department installed the 8-foot wide swirl separator structure adjacent to an existing drainage swale under Northside Plaza. This should improve the water quality of this tributary. Wet weather monitoring was conducted during 2002 downstream from the recently installed BMP. Results were inconclusive regarding pollutant removal rates.

A grant was awarded to Manchester Conservation Commission in January 2002 for a water quality improvement project on a tributary on the pond's east side (2E). The grant, Section 319 local watershed initiative funds, will pay for design and construction of a water quality improvement system in the East Inlet 2 (2E) drainage. The tributary collects runoff from approximately 66 acres of mixed-use land including a residential neighborhood and several large active commercial/industrial lots. The system will be designed to infiltrate as much storm water as possible and remove pollutants from runoff that does not get infiltrated. The project work is expected to take place during the summer and fall of 2003.

During the fall of 2002, an environmental engineering firm, Comprehensive Environmental, Inc (CEI) was contracted to design plans to address items 1 & 2. The final design plans are now complete and are in the process of going out to bid for a contractor. The projects are expected to begin early fall, 2003.

3) Perform wetland function study in the north end.

4) Perform possible sediment dredging in the north end to lessen nutrient load.

5) Address Goldfish Pond drainage by including outlet in regular sampling schedule and working with Hooksett Conservation Commission. Goldfish pond is a waterbody, half in Hooksett and half in Manchester, which drains into Dorrs Pond.

As of April, 2003, the UPRP will begin sampling the outlet of Goldfish Pond.

6) De-Channelize Ray Brook at outlet of Dorrs Pond

Outreach/Education:

1) Retrofit and provide educational materials in kiosk at Livingston Park.

An Eagle-Scout will be working on retrofitting this kiosk during May 2003

2) Provide fertilizer education through signage at kiosk.
3) Address duck feeding through signage in kiosk and on shore.
4) Address invasive species through signage at boat ramp and kiosk.

A series of color, laminated fact-sheets and posters has been created to be posted in the kiosks during the summer of 2003. These include a map of the waterbody/watershed, fact-sheets for water quality results, the history of the waterbody, and non-point source pollution issues, and posters on common exotic plants and common fish. In addition, a sign restricting duck feeding has been posted on the shoreline, and a public-awareness sign regarding milfoil will be posted at the boat launch.

5) Address organic debris accumulation at dam through collaboration with Parks & Recreation.

This is done annually by the Parks & Recreation Department.

Recreational:

1) Work with Parks & Recreation with trail/Parking lot enhancement projects.

Trail improvements are also underway around the pond. In 2001, the Manchester Parks Recreation and Cemetery Department received a grant from the Land and Water Conservation Fund to carry out a major trail improvement project at Livingston Park. The grant was matched by a private local fund. The improvement plan will consist of trail improvements, handicap accessibility through approximately 50% of the trail network, boardwalk and bridge construction and viewing areas with benches. Bridges will be installed over seasonal stream crossings lessening the likelihood of stream channel disturbance and erosion. The park parking lot will be served by a runoff treatment system consisting of a sunken vegetation island.

Land Preservation:

1) Support the advocacy of land conservation in areas where there is development pressure.
2) Provide careful consideration of land acquisition within the watershed.
3) Secure adjacent parkland through zoning/easements and possible creation of "Town Forest."

Water Quality

The overall water quality of Dorrs Pond has not significantly changed over the last twenty years, though it is slightly more degraded now. Conductivity has increased greatly, but phosphorus and chlorophyll-*a* levels seem to have decreased. The approximately 134 acres of city-owned forested woodland which surrounds the pond has prevented pondside development, thus providing the pond a reprieve from receiving any more direct urban runoff than it historically has.

Chlorophyll-*a*

Composite values for chlorophyll-*a* for the upper 1.5 meters ranged from 2.56 to 15.6 mg/m^3, with a median of 8.72 mg/m^3. This was lower than the 1985 DES findings, where the median was 38.84 mg/m^3 and also lower than the 2000 and 2001 readings. These readings indicate a productive water body, i.e. a water body with substantial plant growth. DES considers concentrations greater than 30 mg/m^3 to be a nuisance amount that is indicative of an algal bloom. Composite samples are derived from combining water samples from each meter of the water column from the midpoint of the metalimnion (middle layer) to the surface.

The current year data (the top graph) show that the chlorophyll-a concentration increased from April to June, and then decreased from June to October.

The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is slightly greater than the state mean.

Overall, visual inspection of the historical data (the bottom graph) shows variation in-lake chlorophyll-a trend, meaning that the concentration has fluctuated since monitoring originally began in 1996. It is worthy to note that the mean annual chlorophyll-concentration has steadily decreased from 2000 to 2002. This could mean…

Conductivity

Conductivity in the epilimnion (top layer) ranged from 658 to 1070 uMhos/cm, with a mean of 882.6 uMhos/cm. When the pond was stratified, the hypolimnion (bottom layer) conductivity measured 904 uMhos/cm. This is a slight increase from 2001 and more than twice the conductivity levels recorded in 2000. As expected, the inlets also were highly conductive, averaging 910 and 1202 uMhos/cm each. These are very high conductivity levels, most likely caused by the large amount of urban runoff that this location receives. Conductivity levels (median) have risen by approximately 71% since 1985.

Dissolved Oxygen

Hypolimnion dissolved oxygen readings varied greatly from month to month at Dorrs Pond. This may be due to the shallow area in which readings were taken. The sampling station is relatively close to the dam/outlet which creates a current in this area. Factors influencing pond flow, such as precipitation, may also influence dissolved oxygen concentration in this particular area. As in past years, summer dissolved oxygen levels were depleted in the hypolimnion but levels were more uniform throughout the water column during the spring and fall.

The dissolved oxygen concentration was low in the hypolimnion at the deep spot of the lake/pond on the June and August sampling events. As stratified lakes/ponds age, oxygen becomes depleted in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion, the phosphorus that is normally bound up in the sediment may be re-released into the water column.

pH and Acid Neutralizing Capacity

The pH of Dorrs Pond ranged from 6.84 to 7.26, with an average of 7.12. pH values in the 1985 DES study were not significantly different than those taken in 2000, 2001 or 2002. The 1985 median was 7.0. Alkalinity, or Acid Neutralizing Capacity (ANC) ranged from 17.6 to 33.1 mg of CaCO/L, with an average of 26.5 mg/L in 2002. This is an increase of 77% since 2000. The 1985 DES alkalinity median value was 15.4 mg/L of CaCO.

The Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) continued to increase this season and is much greater than the state mean of 6.7 mg/L (Table 5). Specifically, this means that the lake/pond is “not vulnerable” to acidic inputs (such as acid precipitation).

Total Phosphorus

The total phosphorus concentration (TP) measured in the epilimnion of Dorrs Pond varied from .013 to .037 mg/L, with a mean of .021 mg/L. This is a slight reduction from TP levels measured in 2001. When the pond was stratified, TP in the lower level or hypolimnion reached 0.127 mg/L. Two of the pond’s main inlets are still significant sources of phosphorus input, even with apparent reduction from last year. Lessard’s Brook averaged 0.025 mg/L of TP (35% reduction from 2001) and Inlet 2 East averaged 0.021 mg/L of TP (13% reduction from 2001). The ‘81-’82 DES study found a median of .042 mg/L TP in the epilimnion, 100% higher than 2002 levels. Twenty years have apparently changed phosphorus inputs to Dorrs Pond. The 2002 data seem to show great reductions. Possible explanations for this are discussed the “Short Term Changes” section. These inlets drain highly urbanized areas. See Table 4 for a comparison between 1985, 2000, 2001 and 2002 values.

The current year data for the epilimnion (the top inset graph) show that the total phosphorus concentration increased from April to August, and decreased from August to October. The total phosphorus concentration on each sampling event was greater than the state median.

The current year data for the hypolimnion (the bottom inset graph) show that the total phosphorus concentration was only measured in August this season. The concentration in August was much greater than the state median.

Overall, visual inspection of the historical data trend line for the epilimnion shows relatively stable total phosphorus trend since monitoring began in 1996. However, it is important to note that the mean annual phosphorus concentration in the epilimnion has decreased since 2000. Again, we hope this trend continues!

Overall, visual inspection of the historical data trend line for the hypolimnion shows an increasing total phosphorus trend, which means that the concentration has worsened in the hypolimnion since monitoring began.

The total phosphorus concentration increased in the Juniper Street Inlet this season. The phosphorus concentration for this station was very high in October (735 ug/L), however, the turbidity of the sample was also very high (194 NTUs), which suggests that the stream bottom may have been disturbed while sampling. However, the volunteer monitor noted on the data sheet that "orange specks (paint?)" was observed in the water when the sample was collected.

Transparency

Secchi disk transparency ranged from 1.2 to 2.35 meters, with a median of 2.05 meters. The minimum transparency was recorded in June. Water clarity and chlorophyll-*a* concentrations seem to be somewhat related since water clarity has improved since 2000 and chlorophyll-*a* concentrations have reduced since 2000.
The current year data (the top graph) show that the in-lake transparency decreased from April to June, and then increased from June to September.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a stable trend for in-lake transparency, meaning that the transparency has been approximately the same since monitoring began in 1996. However, it is important to point out that the mean annual transparency has increased from 2000 to 2002. We hope that this trend continues!

Turbidity

Turbidity of epilimnion samples ranged from 2.86 to 3.76 (NTU), with an average of 3.22 (NTU) in 2002, roughly the same as in 2000. High turbidity is most likely caused, in this case, by a large volume of urban runoff to this location. Turbidity measurements were not taken at Dorrs Pond during the 1985 DES Diagnostic/Feasibility Study.

As was discussed previously, the turbidity in the Juniper Street Inlet sample was very high on the October sampling event. The volunteer monitor noted on the field data sheet that "orange specks" (likely iron bacteria or particulate iron) were observed in the water at this station when the sample was collected. This seems to have affected the turbidity levels as well as the phosphorus concentration in the sample.

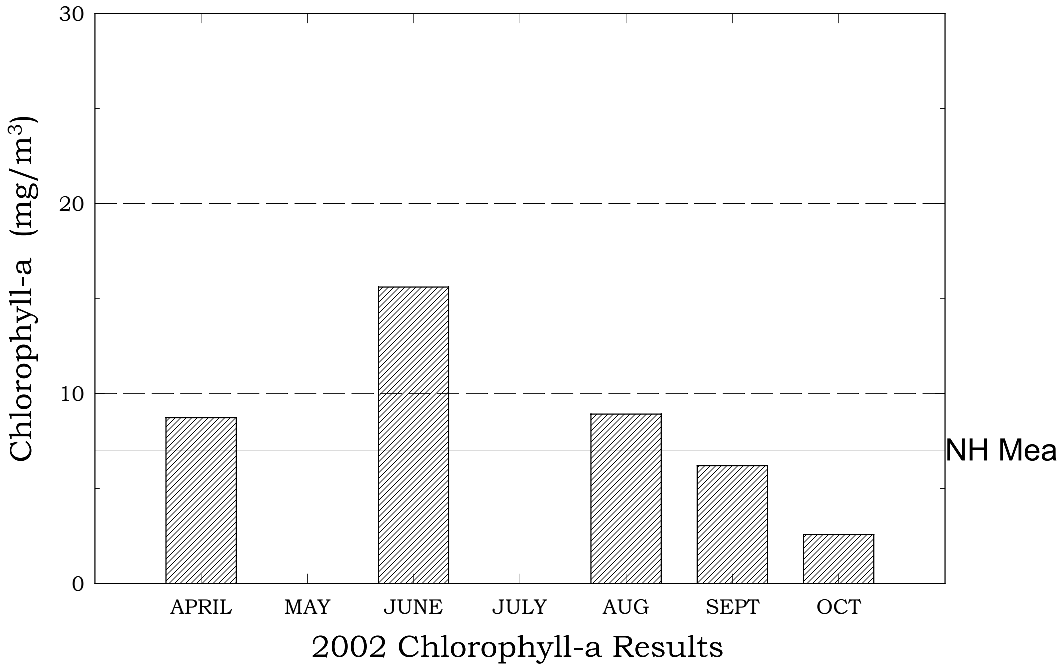
Table 3[1]
Comparison of Dorrs Pond – 1981*, 1985**, 1997+, 2000 - 2002

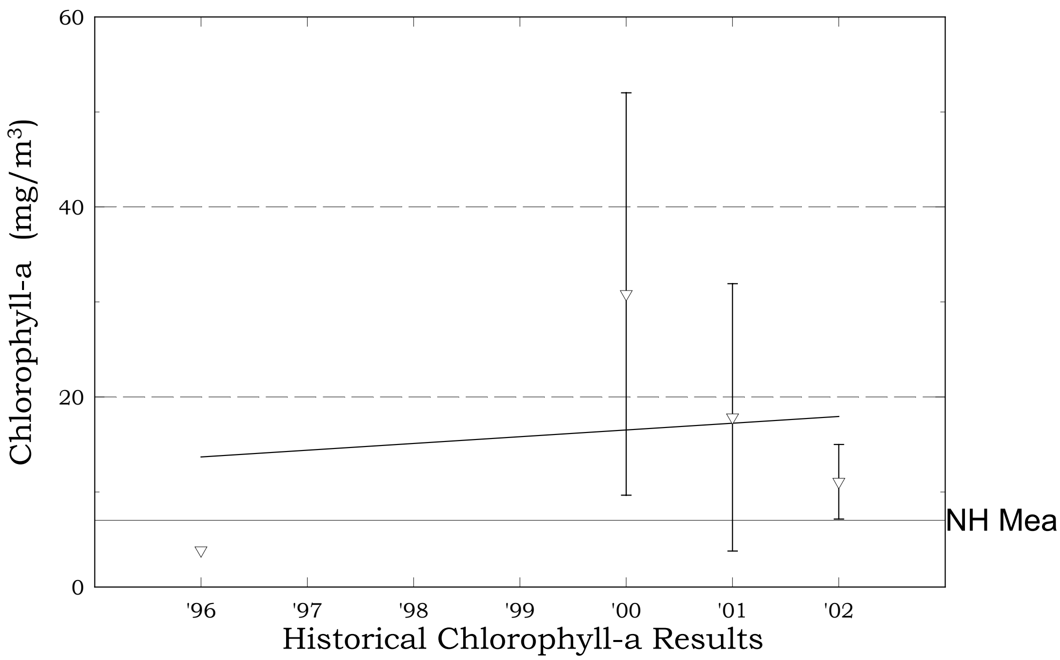
Parameter	7/14/81	1985 Median	7/17/97	2000 Mean	2000 Median	2001 Mean	2001 Median	2002 Mean	2002 Median
pH	6.8	7.0	7.1	7.08	7.08	7.15	7.09	7.07	7.07
Alkalinity (mg/l)	13.9	15.4	22.2	16.2	--	21.7	21.9	26.5	26.5
Total Phosphorus (mg/l)	0.060	0.042	0.031	0.045	--	0.024	0.024	0.021	0.021
Conductivity (uMhos/cm)	201	258	469	408	--	831.3	851.0	882.6	899.0
Secchi Disk (m)	1.3	1.6	1.3	1.1	1.0	1.3	1.1	2.0	2.0
Chlorophyll-*a* (mg/m3)	--	38.84	--	30.84	--	14.75	9.74	8.40	8.72

1) All values are epilimnetic, except chlorophyll-*a* which is a composite.
* NH Dept. of Environmental Services. 1981. Trophic Classification of NH Lakes and Ponds.
** Estabrook, R., et.al. 1985. Urban Lakes Diagnostic/Feasibility Study. Staff Report No. 140. New Hampshire Water Supply and Pollution Control Commission.
+ NH Dept. Of Environmental Services. 1998. Lake Trophic Data.

Dorrs Pond, Manchester

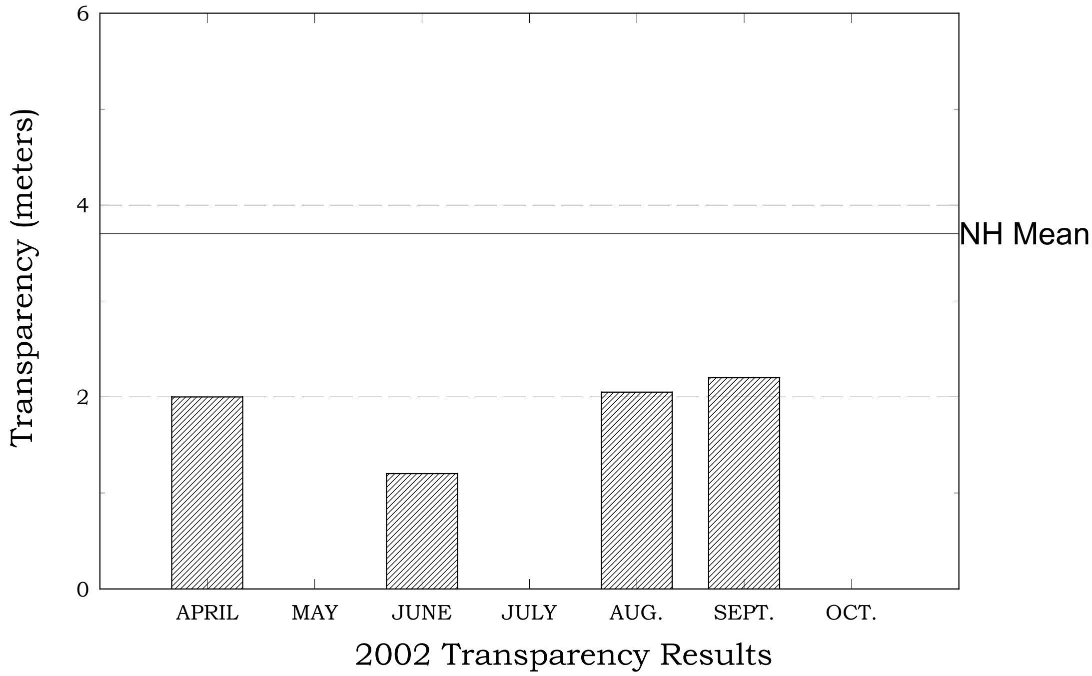
Figure 1. Monthly and Historical Chlorophyll-a Results

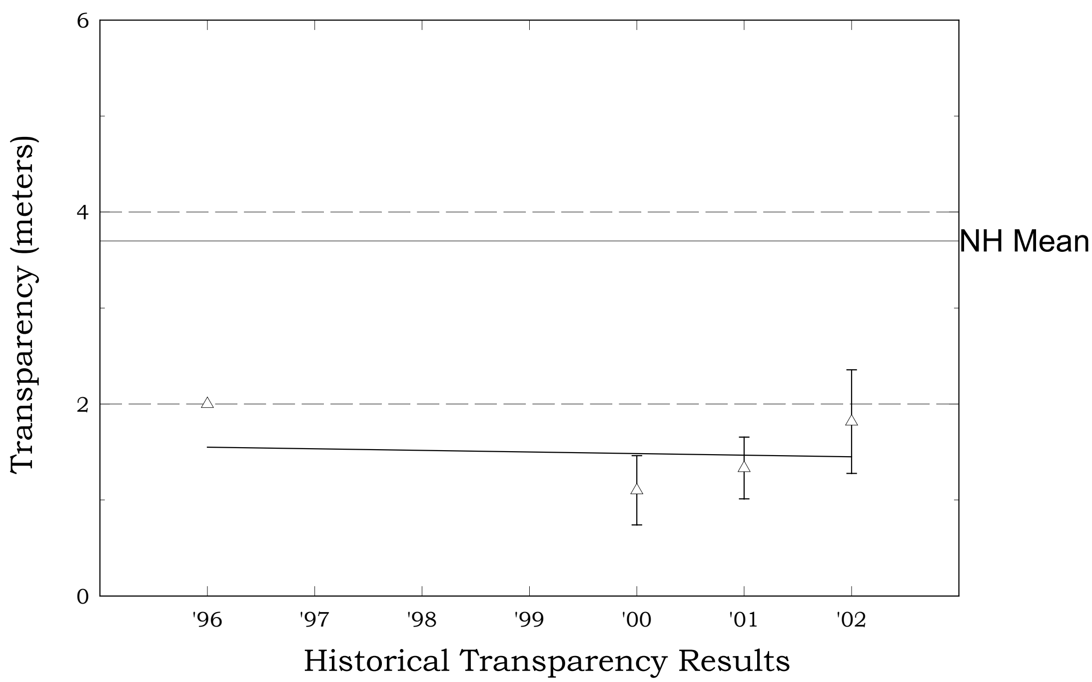




Dorrs Pond, Manchester

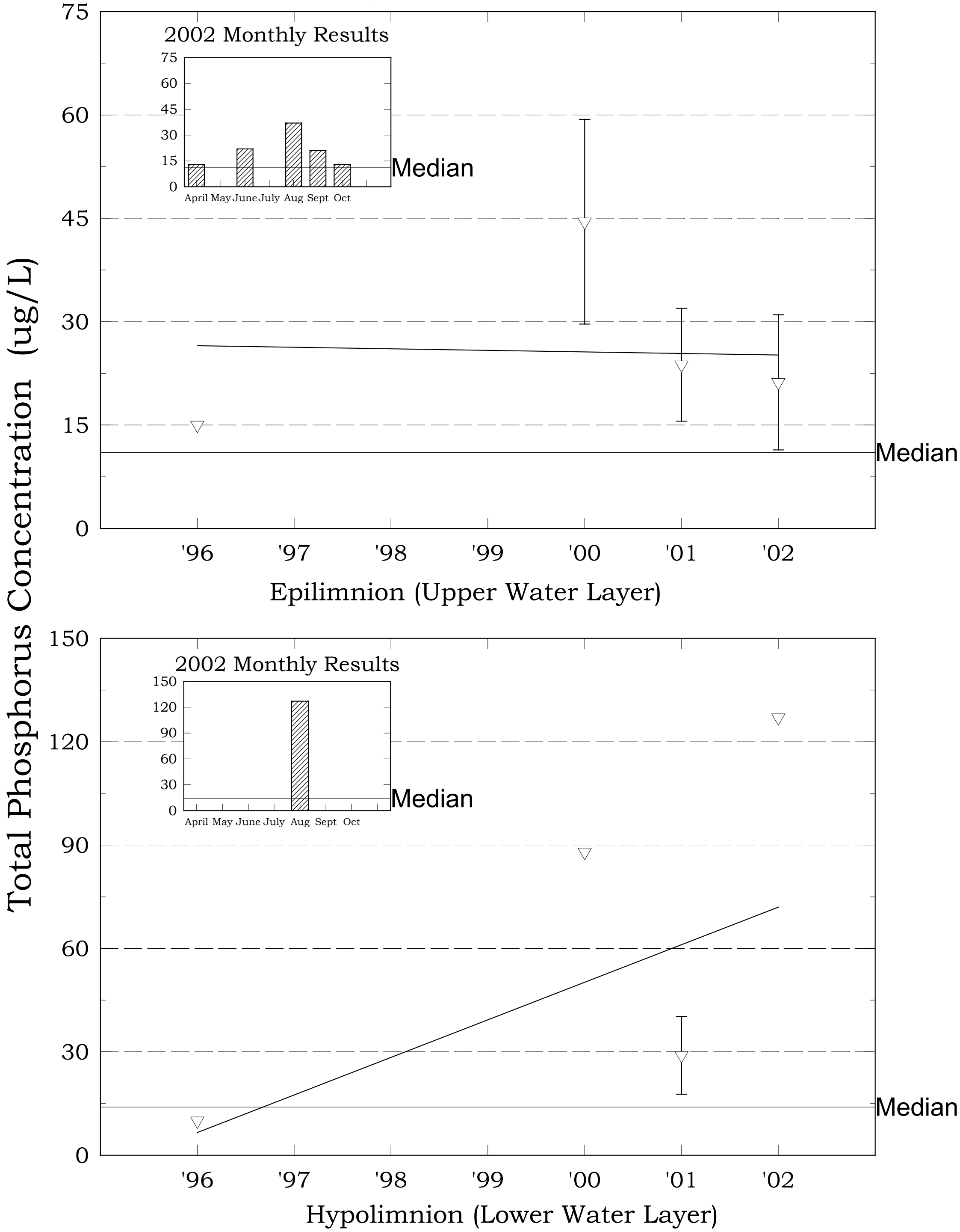
Figure 2. Monthly and Historical Transparency Results





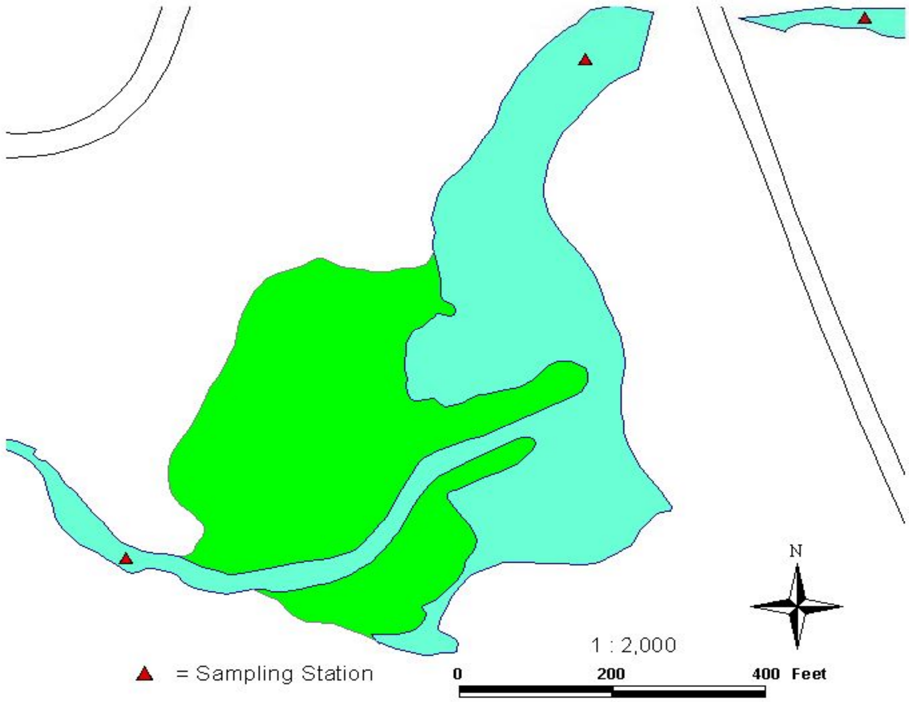
Dorrs Pond, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.



Maxwell Pond

Figure 4 – Maxwell Pond Sampling Stations



Pond Location and Description

Maxwell Pond, located on Front Street at the intersection of Dunbarton Road, is formed as an impoundment of Black Brook. It has limited recreational uses, as it is quite shallow. A trail system encircles the pond, and a playground is located by the dam on Front Street.

Pond Goals & Project Status

Goal(s): To assess the feasibility of dam removal and to conduct a habitat assessment.

Water Quality:

1) Conduct a dam removal feasibility study.
2) Address upstream sedimentation.
3) Address apartment complex runoff/drainage issues.
4) Assess habitat enhancement and support an increase of biodiversity.

Plans are currently being discussed for possible dam removal at Maxwell Pond. In partnership with DES and Trout Unlimited (TU) the UPRP is assisting with a feasibility study at Maxwell Pond to determine baseline conditions, and formulate hypotheses regarding the reaction of Black Brook to dam removal. Identification of existing channel location and conditions as well as historic, pre-dam channel characteristics is crucial to understanding the long term effects that dam removal may have on this site and the Black Brook corridor as a system. The dam removal feasibility study workplan includes aerial topographic surveying, stream channel morphology study, bathymetric survey and sediment depth mapping of Maxwell Pond, water quality monitoring of Maxwell Pond, and biomonitoring of Black Brook including macroinvertebrate surveys and fish surveys. If the dam is removed, approximately six miles of free-flowing stream would be restored.

Trout Unlimited was awarded a $13,850 grant from the NH DES local watershed initiative grant program in 2002 to conduct the first phase of the Black Brook corridor study, including photogrammetric mapping. This project produced an up-to-date aerial topographic map accurate to a contour interval of one foot.

Concurrent with the dam removal study, a restoration plan is being created for a disturbed site upstream of Maxwell Pond. A concrete aggregate and transportation operation has been impacting Black Brook for several years. Impacts include channel obstruction and filling as well as sedimentation and artificial bank armoring. The property owner has been cooperating with DES authorities to remedy the problems on the site, as well as to reconfigure stream crossings to allow proper fish passage and possibly relocate the stream channel to its historic location.

A Black Brook Advisory Committee (BBAC) has formed to take the project to the next level. City personnel from various commissions and departments as well as local citizens were called together to broaden the perspective of the project. The next step is to inform the public and solicit public input regarding the project. If the project is opposed by the general public, other restoration efforts in lieu of dam removal will become the focus of the project.

This project is supported by; the New Hampshire Fish and Game Department, the New Hampshire Department of Environmental Services, the New Hampshire River Restoration Task Force, and local chapters of Trout Unlimited, and the property owners; Wakefield Materials and the City of Manchester. Upstream abutters have expressed interest in the multi-year restoration initiative; several granted permission for the collection of geomorphic reference reach data on their property. The City of Manchester is contributing financially for the topographic survey and channel design work. Wakefield Materials is providing access to its property for the survey work, as well as material, equipment and labor. The NH Department of Environmental Services is providing ground control for the aerial survey and production of CAD-generated hardcopy topographic maps and funding for the bridge replacement. Volunteers from local Trout Unlimited chapters will be assisting with the stream channel topographic surveys, electrofishing, collecting microinvertrabrates, riparian planting, and fry stocking.

Outreach/Education:

1) Construct and provide educational materials in kiosk at Blodgett Park.
2) Examine threat of invasive species.

An Eagle-Scout will be constructing a kiosk for Blodgett Park during May, 2003.

A series of color, laminated fact-sheets and posters has been created to be posted in the kiosks during the summer of 2003. These include a map of the waterbody/watershed, fact-sheets for water quality results, the history of the waterbody, and non-point source pollution issues, and posters on common exotic plants and common fish.

Recreational:

1) Work with Parks & Recreation to improve conditions at Blodgett Park.

Land Preservation:

1) Secure adjacent parkland through zoning/easements.

Water Quality

The water quality of Maxwell Pond is better than any other Manchester Pond. Maxwell has a very high turnover rate and relatively little urban development in the watershed. Its streamlike characteristics allow most pollutants to wash downstream. Rapid sedimentation, due to the dam, and vegetation growth is occurring in some parts of the pond, however.

Chlorophyll-*a*

Chlorophyll_*a* concentrations were very low, ranging from 1.01 to 2.27 mg/m^3, and averaging 1.68 mg/m^3. These low readings are most likely due to the pond's high flushing rate.

The current year data (the top graph) show that the chlorophyll-a concentration decreased from April to May and then increased from May to August. The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is less than the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a stable in-lake chlorophyll-a trend, meaning that the concentration has remained approximately the same since monitoring began in 2000.

Conductivity

Conductivity of Maxwell Pond ranged from 121.1 to 237.0 uMhos/cm, with an average of 201.4 uMhos/cm. DES 1981 data shows conductivity at 56.0 uMhos/cm. Inlet samples ranged from 120.6 to 300.0 uMhos/cm and averaged 185.8 uMhos/cm in 2002.

The conductivity in the pond and in the inlet is relatively high. Typically conductivity levels greater than 100 uMhos/cm indicate the influence of human activities on surface water quality. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity. It is possible that the lower than normal amount rainfall during the latter-half of the summer reduced tributary and lake flushing, which allowed pollutants and ions to build up and resulted in elevated conductivity levels.

Dissolved Oxygen

Dissolved oxygen levels are consistently high in relation to other Manchester ponds due to the stream-like characteristics of Maxwell Pond. The lowest dissolved oxygen saturation recorded at Maxwell Pond was 47.0% at the pond's deepest point. DO levels in 2002 were very similar to those found in 2000 and 2001.

pH and Acid Neutralizing Capacity

The pH at the deep spot this season ranged from 6.17 to 6.76 in the epilimnion, which means that the water is slightly acidic. pH readings at Maxwell Pond have been similar throughout the past three years of sampling. The values are slightly low for NH freshwater ecosystems, but still well within the range for supporting aquatic life. pH readings by NH DES in 1981 were similar at 6.4. ANC was also consistently lower than other

Manchester ponds, ranging from 1.8 to 12.7 mg of CaCO/L, with an average of 6.74 mg/L. In 1981, NH DES found ANC to be 6.4 mg/L. Maxwell is therefore less able to buffer acidic inputs, which may help explain the low pH readings.

The mean Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was 8.17 mg/L as $CaCO_3$, which is slightly greater than the state mean of 6.7 mg/L (Table 5). Specifically, this means that the lake/pond is "moderately vulnerable" to acidic inputs (such as acid precipitation).

Total Phosphorus

Due to the fact that the deepest spot in Maxwell Pond is 1.1 meters, there was no thermal stratification, so only "surface grab" samples were necessary for in-pond sampling. Total phosphorus concentrations ranged from 0.008 to 0.021 mg/L, with an average of 0.015 mg/L. Due to the high turnover of pond volume and shallowness here, inlet samples are especially important. TP concentrations in the inlet samples (Black Brook) peaked at 0.058 mg/L and averaged 0.021 mg/L. The highest reading (0.058 mg/L) occurred during drought conditions.

The current year data for the epilimnion (the top inset graph) show that the total phosphorus concentration increased overall from April to October. The total phosphorus concentration was greater than the state median on each sampling event expect for the April event.

The historical data show that the 2002 mean epilimnetic total phosphorus concentration is greater than the state median.

Overall, visual inspection of the historical data trend line for the epilimnion show a stable total phosphorus trend.

The total phosphorus concentration in the Inlet was elevated on the September sampling event this season (58 ug/L). The turbidity of the sample was also elevated (5.09 NTUs), which suggests that the stream bottom may have been disturbed while sampling. When the stream bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column.

Transparency

As the bottom could clearly be seen at 1.1 meters, Secchi disk transparency was >1.1 meters and could not be measured more accurately due to lack of depth. The transparency was greater than the pond depth, i.e. one can see the pond bottom. The Secchi-disk was visible on the bottom of the pond on each sampling event.

As the transparency can not be accurately measured due to the shallowness of the pond, it isn't possible to determine a trend.

Turbidity

Turbidity in Maxwell Pond ranged from 1.19 to 2.67 (NTU) and averaged 2.16 (NTU). NH DES 1981 turbidity readings were a bit higher at 4.3 (NTU).

Maxwell Pond water quality has remained consistent since 2000, with the exception of conductivity (which has increased by 72%). Three years of data, however, do not accurately represent a trend. Natural fluctuations, upstream disturbances and discharges, and precipitation variations could all be singled out as reasons for water quality fluctuations.

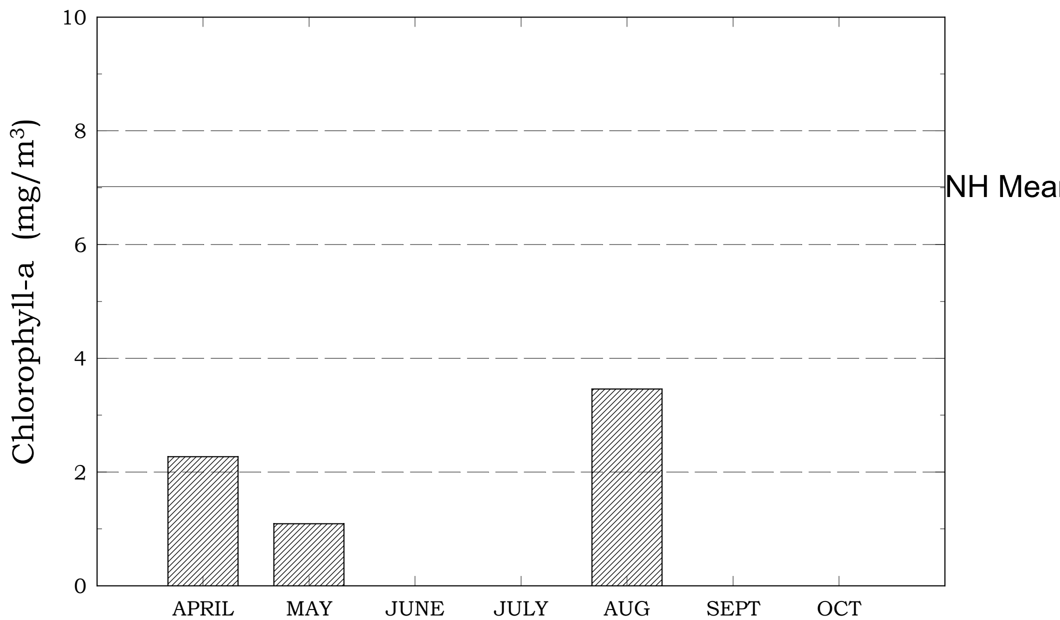
Table 4[1]
Comparison of Maxwell Pond – 1981*, 2000 & 2001

Parameter	1981	2000 Mean	2000 Median	2001 Mean	2001 Median	2002 Mean	2002 Median
pH	6.4	6.54	6.55	6.63	6.62	6.50	6.52
Alkalinity (mg/l)	7.0	6.8	6.9	9.8	9.6	6.74	3.6
Total Phosphorus (mg/l)	0.018	0.014	0.014	0.018	0.018	0.015	0.016
Conductivity (uMhos/cm)	56.0	121.8	127.3	154.6	148.5	201.4	147.8
Secchi Disk (m)	>1.2	>1.1		>1.1		>1.1	
Chlorophyll-*a* (mg/m3)		1.55	1.07	3.17	4.01	1.68	1.68

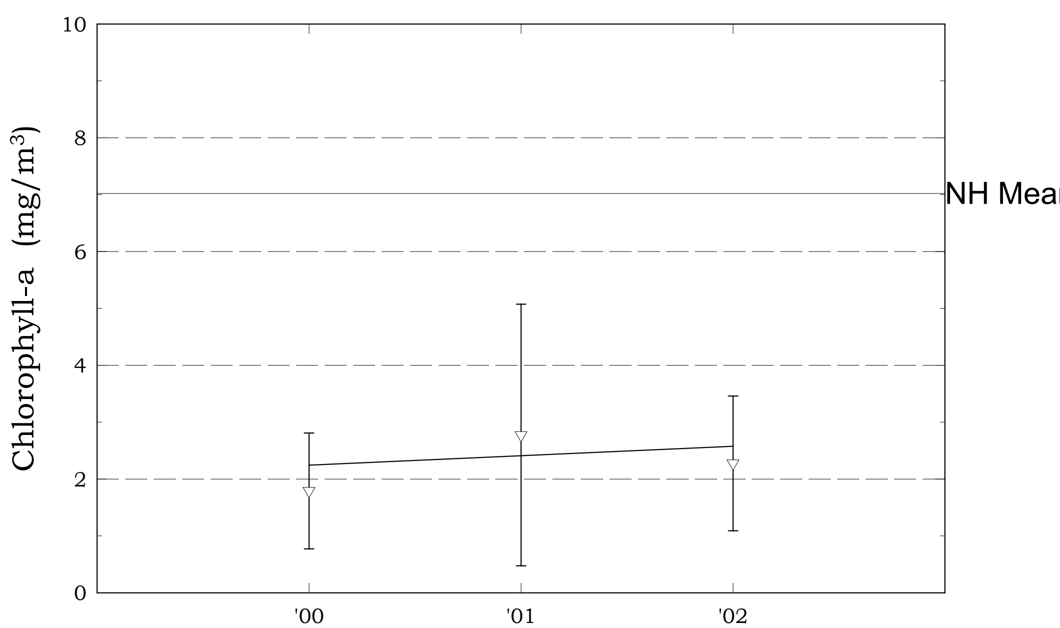
1) All values are epilimnetic.
* NH Dept. of Environmental Services. 1981. Trophic Classification of NH Lakes and Ponds.

Maxwell Pond, Manchester

Figure 1. Monthly and Historical Chlorophyll-a Results



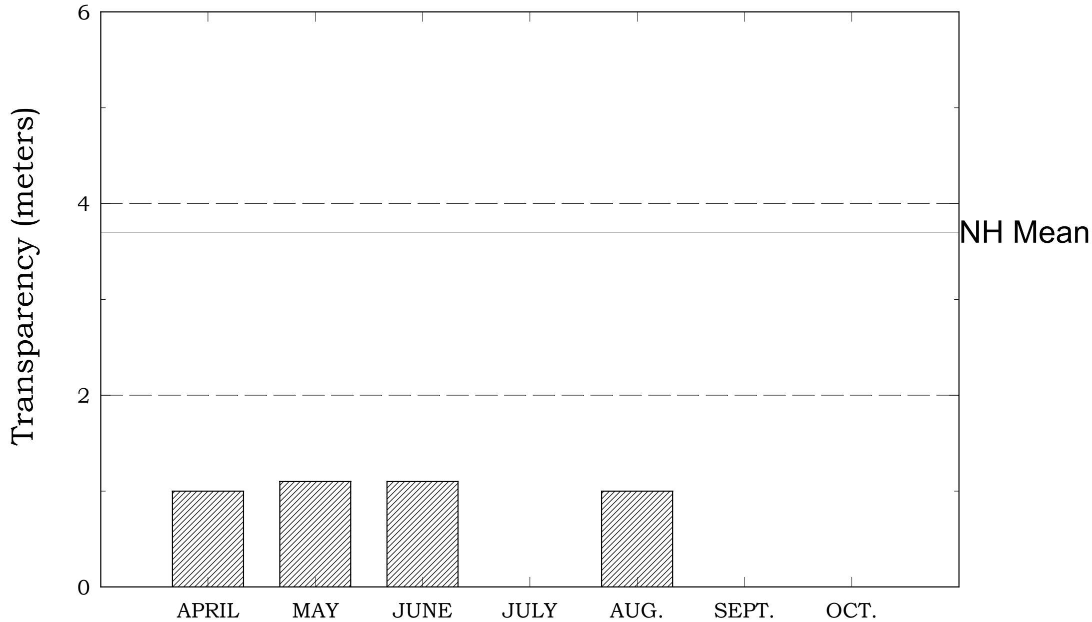
2002 Chlorophyll-a Results



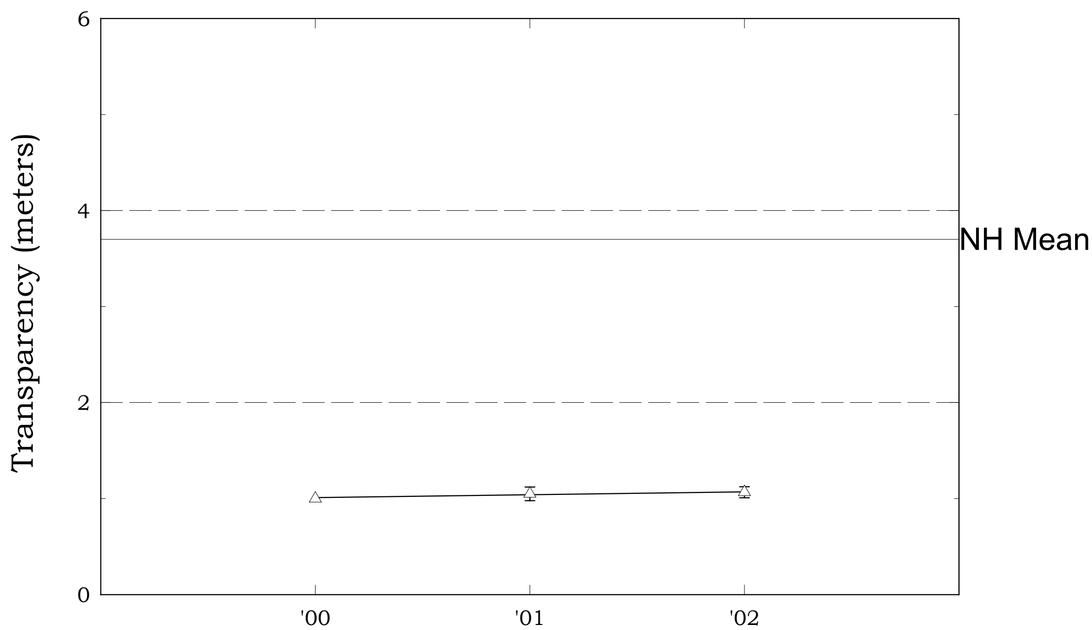
Historical Chlorophyll-a Results

Maxwell Pond, Manchester

Figure 2. Monthly and Historical Transparency Results



2002 Transparency Results

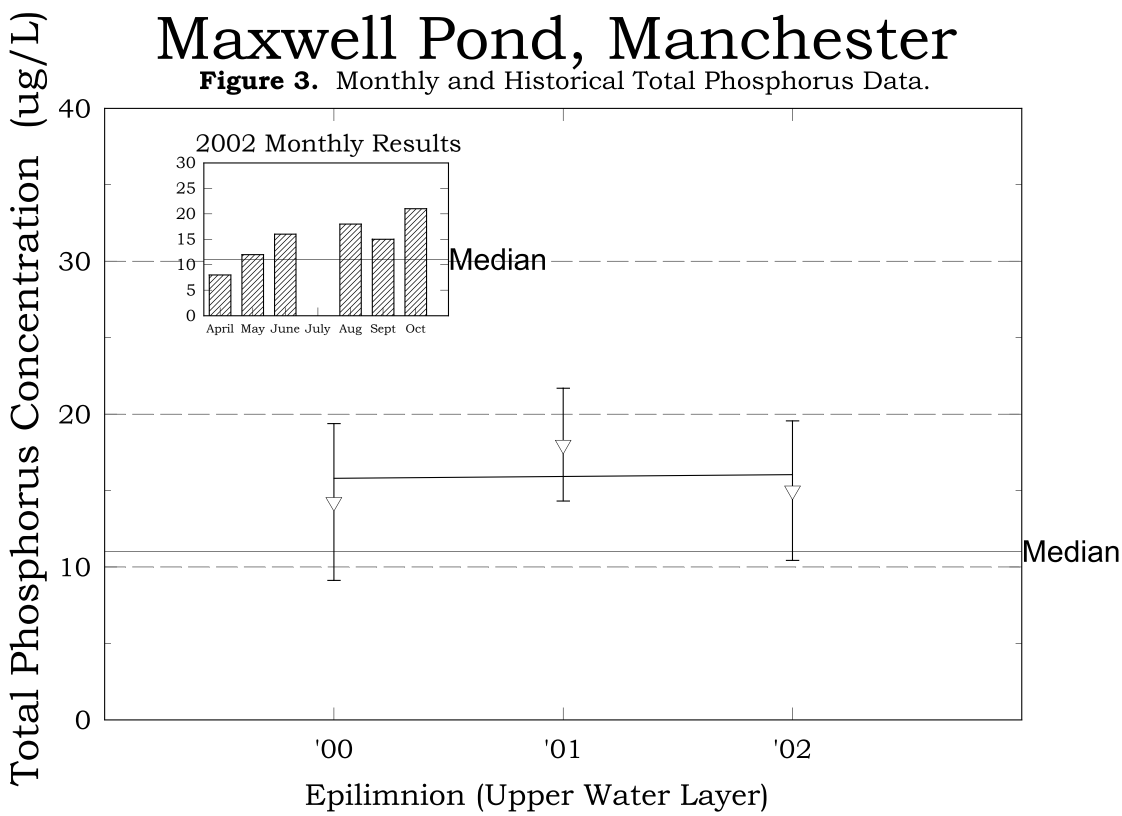


Historical Transparency Results

Transparency can’t be graphed, because it couldn’t be measured, because the water was too shallow.

Maxwell Pond, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.



McQuesten Pond

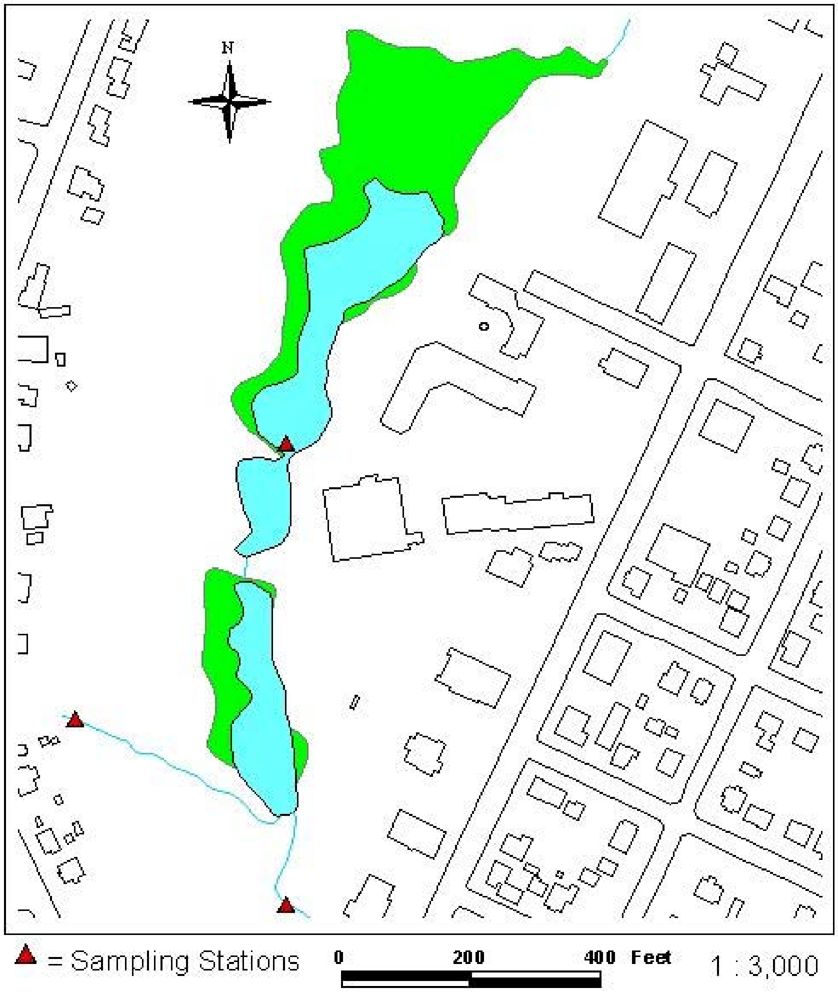


Figure 4 – McQuesten Pond Sampling Stations

Pond Location and Description

McQuesten Pond, located behind the businesses of Second Street is a wetland complex. It has limited recreational uses, as it is quite shallow and is privately owned. Wolfe Park abuts the pond to one side. Migrating birds are frequent visitors.

Pond Goals & Project Status

Goal(s): To secure conservation easements on private property adjacent to the pond.

Water Quality:

1) Long Term: Reduce pavement and restore shoreland in adjacent parking lots.
2) Short-Term: Advocate for on-site stormwater treatment systems.

Outreach/Education:

1) Construct and provide educational materials in kiosk at Wolfe Park.
2) Address invasive species through signage at kiosk and mailing to property owners.
3) Address duck feeding through signage at kiosk.

An Eagle-Scout will be constructing a kiosk for Wolfe Park during May, 2003.

A series of color, laminated fact-sheets and posters has been created to be posted in the kiosks during the summer of 2003. These include a map of the waterbody/watershed, fact-sheets for water quality results, the history of McQuesten Pond, and non-point source pollution issues, and posters on common exotic plants and common fish. In addition, a sign restricting duck feeding has been posted on the shoreline, and a public-awareness sign regarding milfoil will be posted at the boat launch.

4) Address adjacent dumpster & lot runoff through business mailings and site visits.

Recreational:

1) Construct a board walk at north end of pond.

The UPRP is hoping an Eagle Scout will work on this project during 2004.

Land Preservation:

1) Secure conservation easements on private property abutting pond.

Since McQuesten Pond is largely privately owned, City funded conservation projects are not feasible at this time on most of the pond. The focus remains on obtaining easements or ownership from key property owners of the wetland and open water areas. In the mean time, conservation efforts will continue at the city-owned Wolf Park side of the pond.

Water Quality

McQuesten Pond is in essence, little more than a flooded wetland. It is highly biologically productive partly because of its shallow depth and rich sources of organic debris. Therefore, it is inappropriate to compare this water body to other typical New Hampshire lakes and ponds. The water quality at McQuesten Pond remains consistent after three years or data collection.

Inlet and outlet samples were taken at McQuesten Pond, with a few in-pond samples. McQuesten Pond is less than 18 inches deep in any spot, therefore in-pond sampling was not appropriate here. The flushing rate of the ponded area of the McQuesten wetland complex is high, therefore the inlet and outlet samples are believed to be adequately representative of the larger water body. Sampling was therefore done at the inlets and outlets.

Chlorophyll-a

Overall, visual inspection of the historical data trend line (the bottom graph) shows *a decreasing* in-lake chlorophyll-a trend, meaning that the concentration has *improved* since monitoring began in 2001. However, please keep in mind that this trend is based on an extremely limited data set, and may not be representative of actual conditions.

Total phosphorus concentrations in the pond ranged from 0.032 to 0.056 mg/L, averaging 0.045 mg/L. Inlet TP concentrations were lower at 0.01 mg/L. Outlet TP concentrations ranged from .032 to .042 mg/L. As in previous years, the differences between inlet and outlet concentrations suggest phosphorus loading from inputs from the commercial business strip directly adjacent to the east side of McQuesten Pond on Second Street and large amounts of organic debris present in the pond.

Conductivity

In-pond conductivity was high, averaging 597.7 uMhos/cm. Outlet conductivity levels were similar at 596.7 uMhos/cm.

The conductivity continues to be very high in the pond, inlets, and outlet (Table 6). Typically, sources of elevated conductivity are due to human activity. These activities include road and parking lot runoff (which contains road salt during the spring snow melt) and organic debris (such as blowing food from dumpsters). It is possible that the lower than normal amount rainfall during the latter-half of the summer reduced tributary and lake flushing, which allowed pollutants and ions to build up and resulted in elevated conductivity levels.

Dissolved Oxygen

No data are available for dissolved oxygen, as the pond is too shallow for this test.

pH and Acid Neutralizing Capacity

McQuesten Pond had an average pH of 6.96. Acid neutralizing capacity was relatively high at 36.83 mg/L of CaCO compared to the nearly neutral pH average.

The pH at the deep spot this season ranged from 6.56 to 7.47 in the epilimnion (top layer), which means that the water ranged from being slightly acidic to slightly basic (meaning alkaline).

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

The Acid Neutralizing Capacity (ANC) of the surface waters of the pond continue to remain high, with the mean this season (36.83 mg/L as $CaCO_3$) being much greater than the state mean (Table 5). This indicates that the pond is "not vulnerable" to acidic inputs (such as acid precipitation) and has a greater ability than most lakes and ponds in the state to buffer against acidic inputs. While this may seem like a positive condition in the pond, the high ANC is likely due to the degraded conditions of the pond. We suspect that there is a high concentration of pollutants and ions (such as salts) that account for the elevated ANC in the pond.

Phosphorus

The current year data for the epilimnion (the top inset graph) show that the total phosphorus concentration decreased from May to August, and increased from August to September.

The historical data show that the 2002 mean epilimnetic total phosphorus concentration is much greater than the state median.

Overall, visual inspection of the historical data trend line for the epilimnion show an increasing total phosphorus trend, which means that the concentration has worsened in the epilimnion since monitoring began in 2000.

Transparency

No data are available for transparency, as the pond is too shallow for this test. The bottom of the pond is visible.

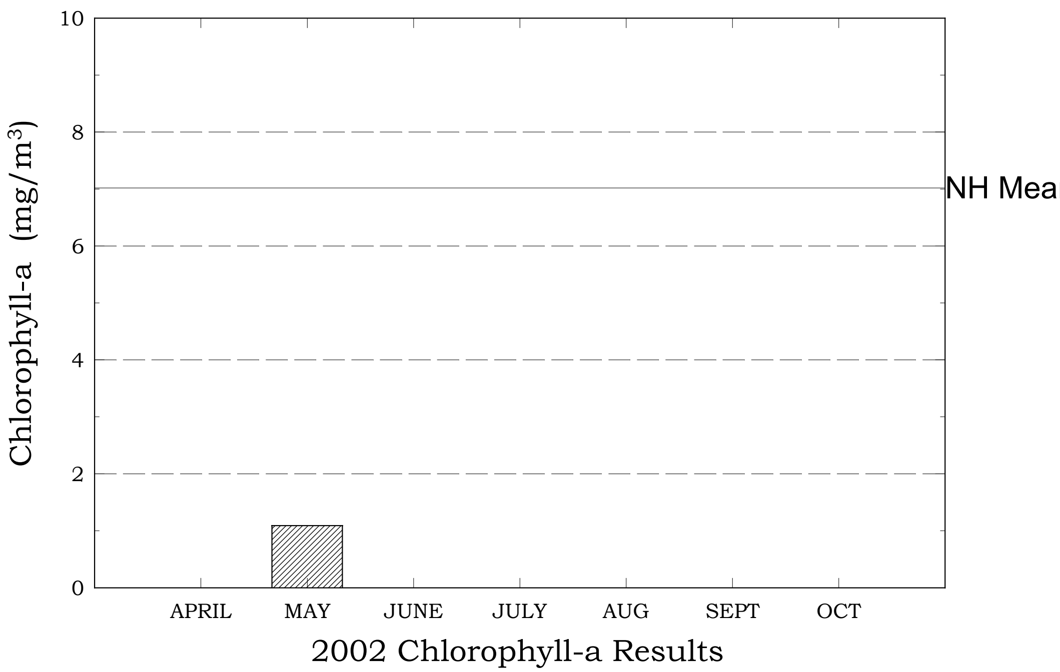
Turbidity

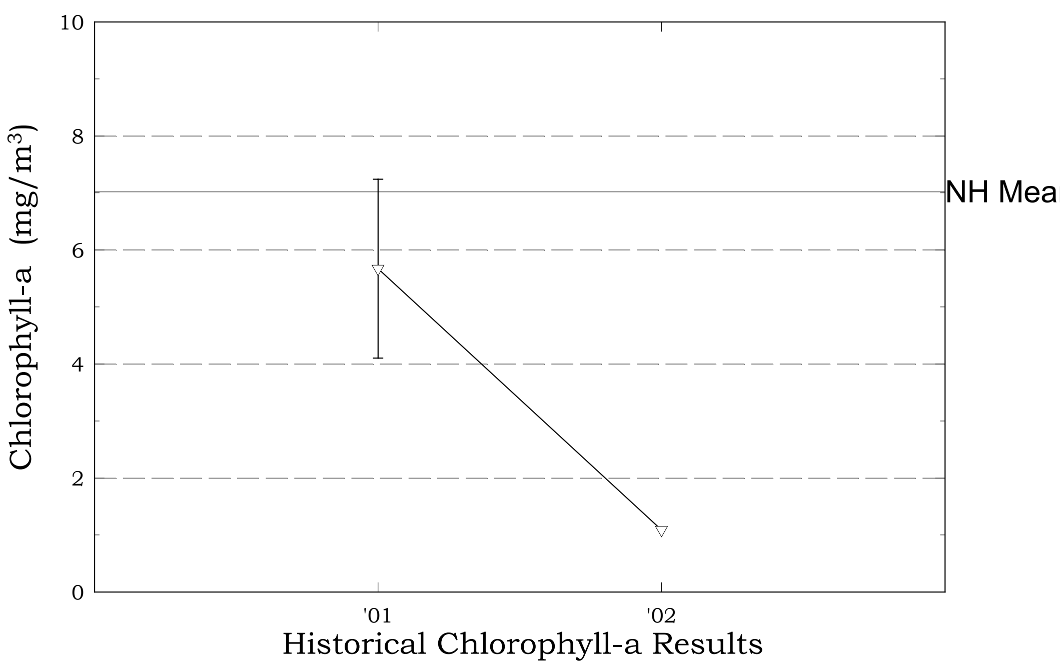
Turbidity readings were high, peaking at 10.3 (NTU) and averaging 6.72 (NTU). Outlet turbidity averaged 2.89 (NTU).

The turbidity in the Epilimnion (top layer) sample was elevated on the September sampling event (10.3 NTUs), which suggests that recent rains may have washed sediment into the pond or that there was a high concentration of algal cells in the water column.

McQuesten Pond, Manchester

Figure 1. Monthly and Historical Chlorophyll-a Results

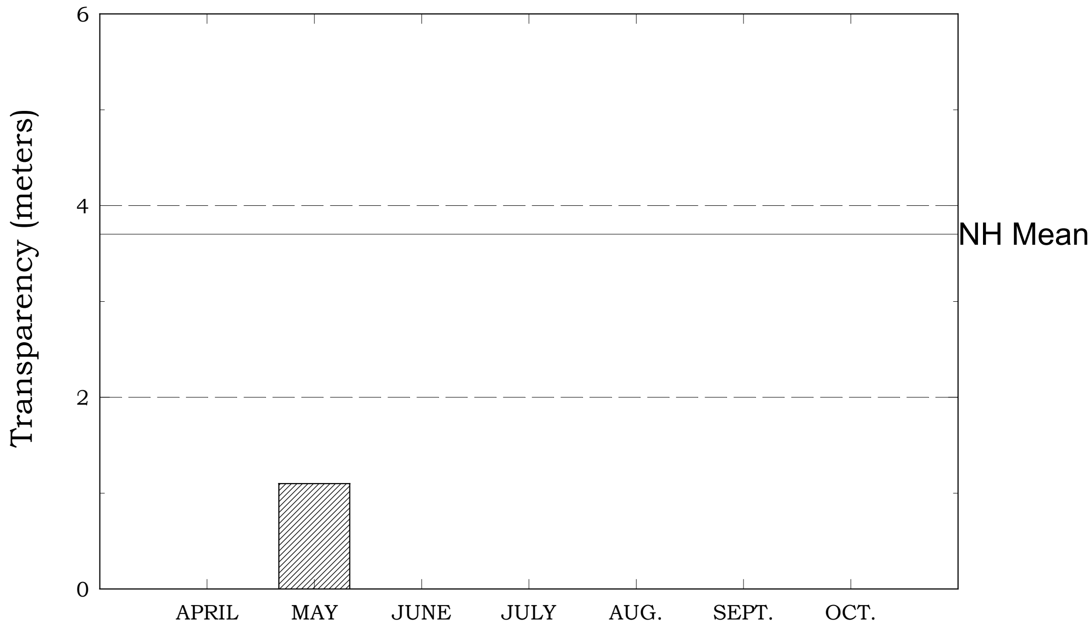




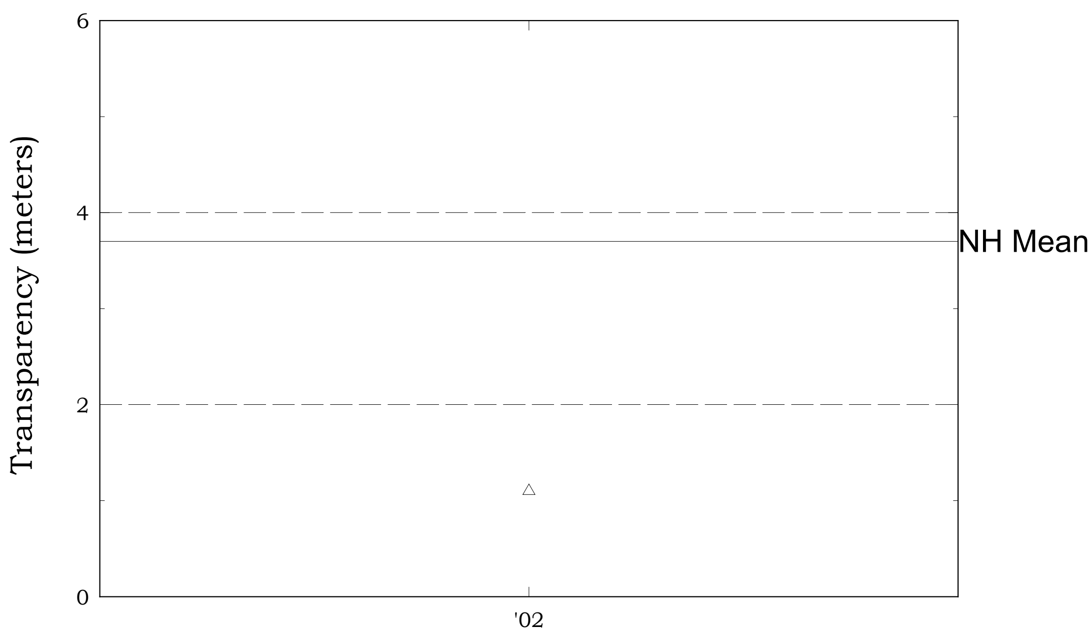
** Error Bars on the sampling results represent +/- 20%, the error in the equipment.

McQuesten Pond, Manchester

Figure 2. Monthly and Historical Transparency Results



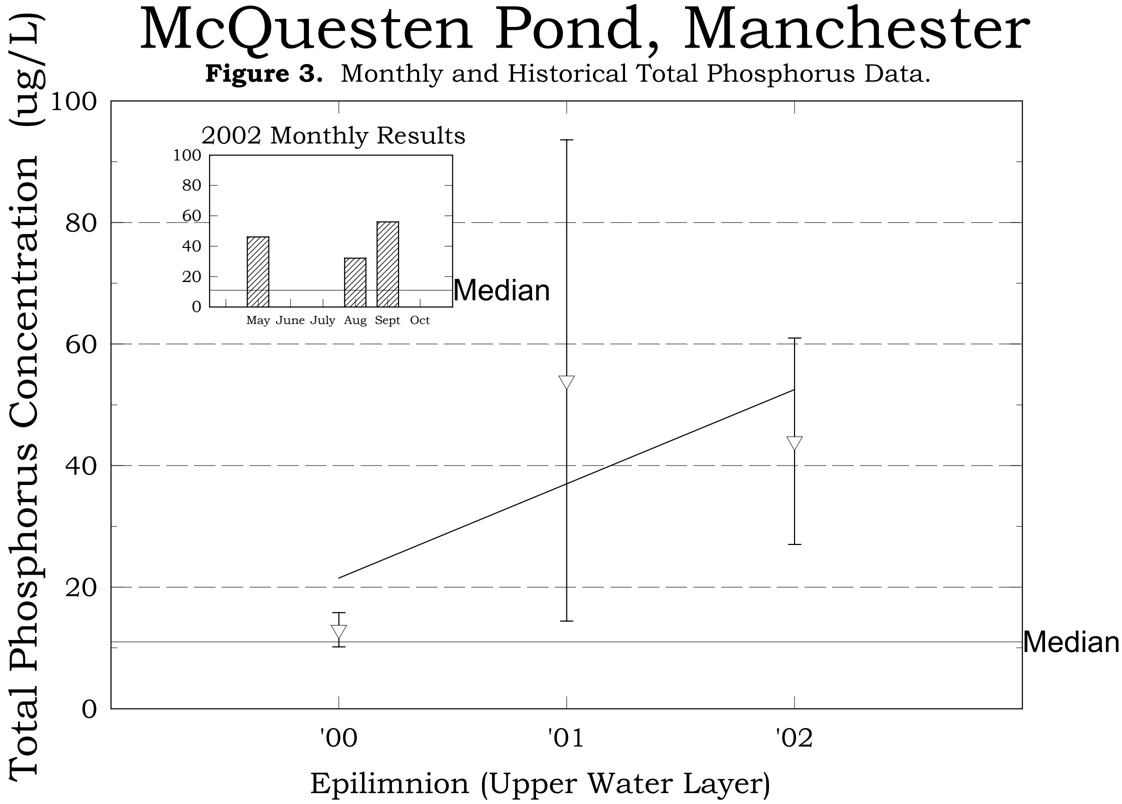
2002 Transparency Results



Historical Transparency Results

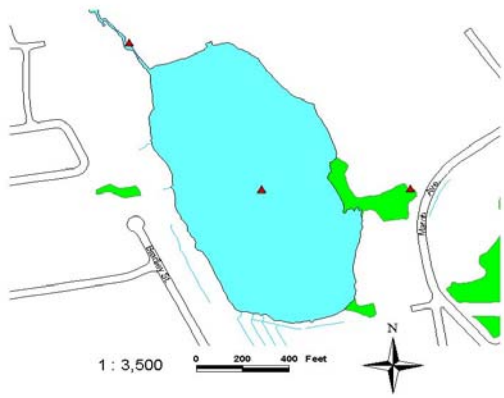
McQuesten Pond, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.



Nutts Pond

Figure 4– Nutts Pond Sampling Stations



Pond Location and Description

Nutts Pond, located behind the businesses of South Willow Street is a popular boating spot. Baseball and soccer fields abut the pond to the north.

Pond Goals & Project Status

Many challenges face Nutts Pond. In order to successfully restore the pond and adjacent public lands to their once popular and enjoyable conditions, a strong partnership must be developed between the UPRP, the Manchester Parks, Recreation and Cemetery Department and neighborhood activist and trail groups. Through a collaborative effort, a master plan can be developed which would incorporate water quality improvements and recreational enhancements around all sides of the pond. This plan would be based on long-term goals

Goal(s): Improve sport fishing and non-motorized/recreational boating opportunities. Improve water quality.

Water Quality:

1) Address urban runoff at four outfalls by completing a drainage study.

During the winter of 2002 and 2003, a nutrient budget study was conducted for the Nutts Pond watershed by Comprehensive Environmental Inc. (CEI) to help identify the worst pollution sources. The watershed was broken down into five subwatersheds and nutrient inputs were calculated according to land use types in each subwatershed. East Inlet subwatershed, the largest subwatershed area (more the 13 million square feet) was found to be the largest contributor of nutrients to the pond (58%). This subwatershed contains extensive athletic fields, large heavily used paved lots, extensive residential neighborhoods, and several strip malls. This area should be the focus for the first BMP installations at Nutts Pond. Recommendations for possible treatment measures are included a memorandum report by CEI.

2) Investigate opportunities to stabilize shoreline with native plantings.

Outreach/Education:

1) Retrofit and provide educational materials in kiosk at Precourt Park.

An Eagle-Scout will be retrofitting the kiosk at Precourt Park during May, 2003.

A series of color, laminated fact-sheets and posters has been created to be posted in the kiosks during the summer of 2003. These include a map of the waterbody/watershed, fact-sheets for water quality results, the history of the waterbody, and non-point source pollution issues, and posters on common exotic plants and common fish.

2) Provide outreach/education to area businesses through mailings and on-site pollution prevention assessments.

During the summer of 2002, the UPRP developed an on-site pollution-prevention assessment checklist for area businesses. The assessment checklist contains sections for general business information such as solid waste/dumpster maintenance, floor drains, stormwater management, outdoor storage or products or hazardous waste, cleaning products, and sector-specific questions such as used oil, parts washing and absorbents, lead-acid batteries, vehicle washing, (for automotive facilities) and a brief section for supermarkets and food services. There are 84 businesses within Nutts Pond watershed, and the UPRP will separate the businesses into sectors and chose 1/3 to ½ to visit. The on-site assessments will be performed during the summer/fall of 2003. A few weeks prior to the on-site visits, the businesses will be mailed a letter explaining the project, with a list of "topics" and/or some questions. During the on-site visits, the store manager or facilities maintenance person will be requested for assistance. It will be known that these site visits are non-regulatory in nature and are only for outreach/educational purposes. The UPRP will compile the results and create a document/web page based on these results.

3) Address dumpster debris at Precourt Park through partnership with Parks & Recreation and Highway Department.

4) Address invasive species through signage at kiosk and at boat ramp.

In 2001, Brazillian elodea was found and identified at Nutts Pond. The Department of Environmental Services (DES) installed an informational sign at the boat launch during the summer of 2002 and has since mapped the area(s) of infestation. An aquatic herbicide will be used on the invasive plant stand during early summer 2003. The UPRP will also have materials posted in the kiosk on this matter.

Recreational:

1) Partner with Queen City Trails Alliance/Manchester Rails-To-Trails to enhance pond circuit trail.

There is an ongoing project to redevelop the rail corridor on the pond's east side into an alternative transportation trail. There is also interest in improving the ballpark and parking areas on the north side.

2) Investigate use of and potentially improve boat-launch

Water Quality

Nutts Pond receives large amounts of untreated urban runoff. Its watershed consists of strip malls, industrial lots, streets, and residential neighborhoods. Runoff to Nutts Pond receives little to no treatment. Since heavy development began in the area approximately 30 years ago, sediment and pollution has been accumulating in stormwater created deltas at four points in the pond. The pond has high levels of heavy metals in the water column and is heavily influenced by ground water. At this point it remains unknown if the metals found in the water column (particularly iron) are derived from groundwater or other possible sources (such as accumulated debris in the pond or street runoff). Wet weather sampling of Nutts Pond inlets in 2002 did not show unusually high iron concentrations. Nutts Pond has shown steady decline in water quality over the last twenty years, as the table below indicates.

Chlorophyll-a

Composite chlorophyll-*a* concentrations for the upper metalimnion (middle layer) and epilimnion (top layer) ranged from 4.34 to 23.74 mg/m^3 and averaged 10.81 mg/m^3. This is a decrease of 61% since 2000, but this is still a high concentration considering the "typical" value for a NH lake is 3.9 mg/m^3.

The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is greater than the state mean. Overall, visual inspection of the historical data trend line (the bottom graph) shows a decreasing in-lake chlorophyll-a trend, meaning that the concentration has improved since monitoring began in 2002. However, please note that this trend is based on a limited data set.

After 10 consecutive years of sample collection from the lake/pond, we could conduct a statistical analysis of the data. This will allow us to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began. For data less than 10 years, it is difficult to definitively say whether a trend exists.

Chloride

This year was the first year that the chloride concentration was measured at the deep spot of the pond. In New Hampshire, the median chloride concentration for lakes/ponds is 5 mg/l. The values in Nutts Pond this season ranged between approximately 149 mg/l (found in the epilimnion, top layer), and 615 mg/l (found in the hypolimnion, bottom layer). The dramatic change in chloride concentration from the epilimnion to the hypolimnion may indicate the presence of a chemocline (depth in the pond below which chemicals are trapped).

Conductivity

Conductivity levels were very high, especially in the hypolimnion, where readings ranged from 578 to 2250 uMhos/cm, and averaged 1798.2 uMhos/cm. This is related to metals contamination in the water column. Epilimnion conductivity ranged from 469 to 809 uMhos/cm, and averaged 580.4 uMhos/cm. These numbers represent a slight drop in conductivity overall since 2001.

Dissolved Oxygen

Nutts Pond was stratified before sampling began in April of 2002. Each sampling session identified a clearly defined epilimnion, metalimnion, and hypolimnion. Dissolved oxygen was almost nonexistent in the lowest depths of Nutts Pond, regularly measuring as low as 2.0% DO saturation, particularly in late summer. These anoxic (very low oxygen) conditions are causing internal phosphorus loading in Nutts Pond. In other words, the low oxygen is causing organisms in the pond to release phosphorus from the sediments.

The dissolved oxygen concentration was greater than 100% saturation at 0.1, 1.0, and 2.0 meters at the deep spot on the August 23rd sampling event. High amounts of oxygen in the upper layers of the water column can be the result of two different conditions.

Layers of algae can raise the dissolved oxygen in the water column, since oxygen is a by-product of photosynthesis. Considering that the depth of the photic zone (depth to which sunlight can penetrate into the water column) was approximately 1.4 meters on the August sampling date (as shown by the Secchi-disk transparency), and that the metalimnion (middle layer, also the layer of rapid decrease in water temperature and increase in density – a place where algae are often found) was located between approximately 2 and 5 meters, we suspect that an abundance of algae may have contributed to the oxygen super saturation.

Wave action from wind can also dissolve atmospheric oxygen into the upper layers of the water column. Considering that the weather conditions on the August 23rd sampling event were very windy, we suspect that wave action may have also contributed to the oxygen super saturation.

The dissolved oxygen concentration was very low in the metalimnion and hypolimnion at the deep spot of the lake/pond this season. As stratified lakes/ponds age, oxygen becomes depleted in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as it was this season and in past seasons), the phosphorus that is normally bound up in the sediment may be re-released into the water column.

During this season, and many past sampling seasons the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of internal total phosphorus loading (commonly referred to as internal loading) is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as it was this season and in many past seasons), the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column. Depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses.

pH and Acid Neutralizing Capacity

Nutts Pond pH values ranged from 6.62 to 7.01 and averaged 6.77. This is within the range considered ideal for freshwater ecosystems. The ANC values varied very little, ranging from 14.3 to 17.1 mg of CaCO/L and averaging 15.4 mg/L.

Due to the presence of granite bedrock in the state and the deposition of acid rain, there is not much that can be done to effectively increase lake/pond pH.

Phosphorus

As expected, the hypolimnion held the highest concentrations of phosphorus ranging from 0.025 to 0.441 mg/L and averaging 0.179 mg/L. These are by far the highest TP concentrations of any Manchester pond. This is likely due to runoff from surrounding commercial and recreational areas and internal loading. Epilimnion TP values ranged from 0.019 to 0.029 mg/L and averaged 0.024 mg/L. These are very similar to TP levels found in 2001.

The historical data for the epilimnion (upper layer) show that the 2002 total phosphorus mean is much greater than the state median. Overall, visual inspection of the historical data trend line for the epilimnion shows an increasing total phosphorus trend, which means that the concentration has worsened in the epilimnion since monitoring began.

The historical data for the hypolimnion (lower layer) show that the 2002 total phosphorus mean is greater than the state median. Within the months of August and September the total phosphorus concentration reached extreme highs, while in the month of October the concentration returned to a lower level. Overall, the historical data trend line for the hypolimnion shows an increasing total phosphorus trend, which means that the concentration has worsened in the hypolimnion since monitoring began.

Transparency

As in past years, Secchi disk transparency and chlorophyll-*a* content appeared to be related at Nutts Pond. When chlorophyll-*a* was high, transparency was low. Transparency ranged from 1.25 to 5.0 meters, and averaged 2.9 meters.

The historical data (the bottom graph) show that the 2002 mean transparency is less than the state mean.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a relatively stable trend for in-lake transparency, meaning that the transparency has remained approximately the same since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into the lake/pond and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond.

Turbidity

Turbidity was high in Nutts Pond, especially in the hypolimnion where values ranged from 1.4 to 65.1 (NTU) and averaged 43.3 (NTU). Epilimnion turbidity values were much lower, averaging 3.83 (NTU). The high turbidity in the hypolimnion may be due to metals contamination. Turbidity readings in 2002 were similar to those of 2000 and 2001.

The turbidity of the hypolimnion (lower layer) sample was elevated on all sampling events this year, similarly to previous sampling seasons. This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, please check to make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

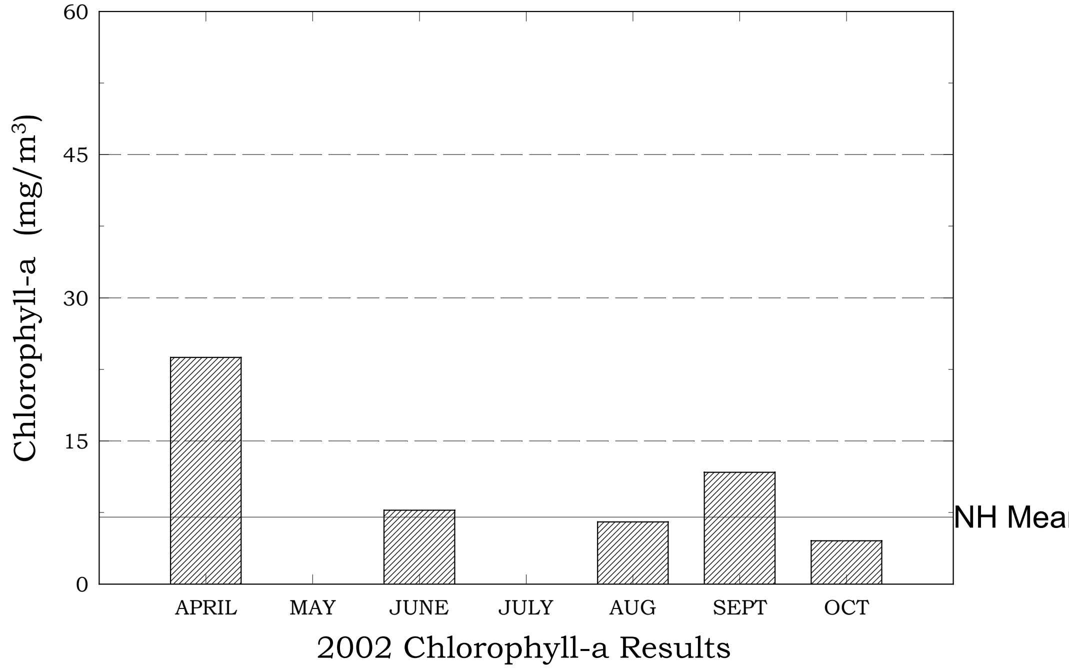
Table 6[1]
Comparison of Nutts Pond – 1981*, 1995, 2000 - 2002**

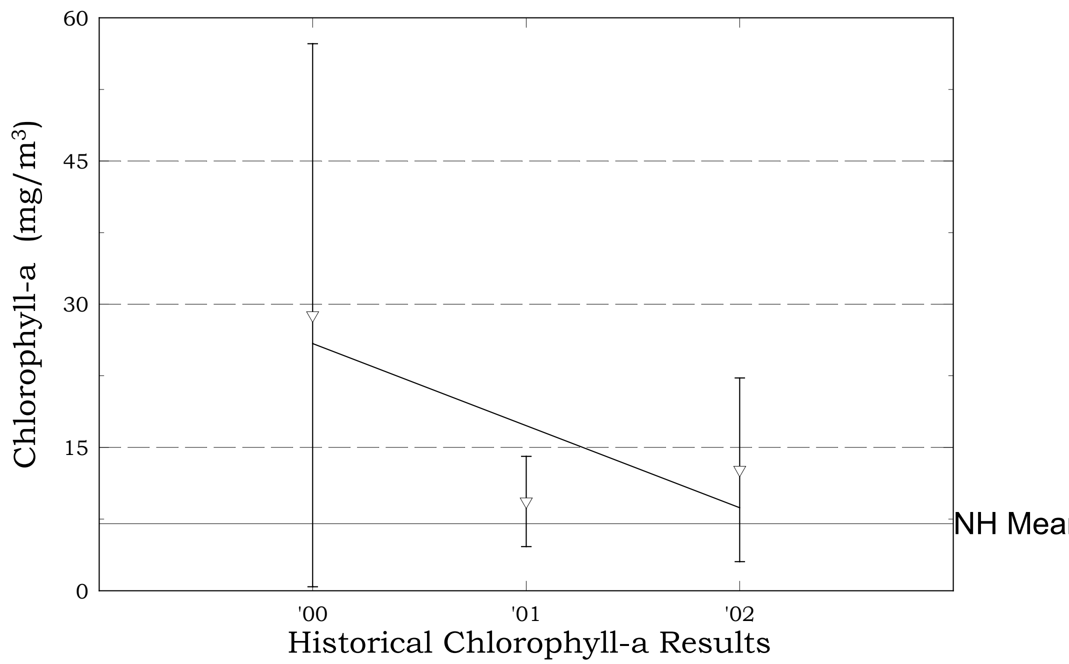
Parameter	1981	1995	2000 Mean	2000 Median	2001 Mean	2001 Median	2002 Mean	2002 Median
PH	7.1	8.9	6.77	6.79	6.82	6.83	6.77	6.77
Alkalinity (mg/l)	12.0	15.8	13.9	14.1	17.3	17.0	15.4	15.4
Total Phosphorus (mg/l)	0.025	0.025	0.015	0.013	0.023	0.019	0.024	0.024
Conductivity (uMhos/cm)	194	567	488	454	714.2	630.5	580.4	546.0
Secchi Disk (m)	2.5	2.5	3.1	3.3	2.4	2.6	2.9	2.9
Chlorophyll-*a* (mg/m3)			27.42	21.12	14.01	10.94	10.81	7.73

1) All values are epilimnetic.
* NH Dept. of Environmental Services. 1981. Trophic Classification of NH Lakes and Ponds.
** NH Dept. of Environmental Services. 1996. Lake Trophic Data.

Nutts Pond, Manchester

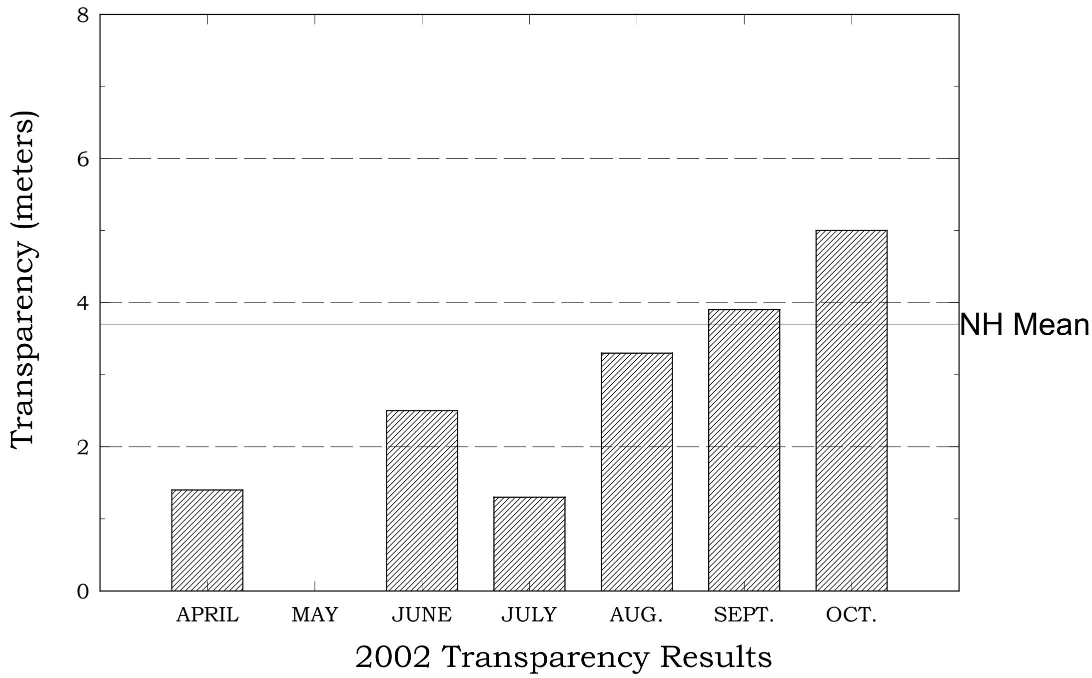
Figure 1. Monthly and Historical Chlorophyll-a Results

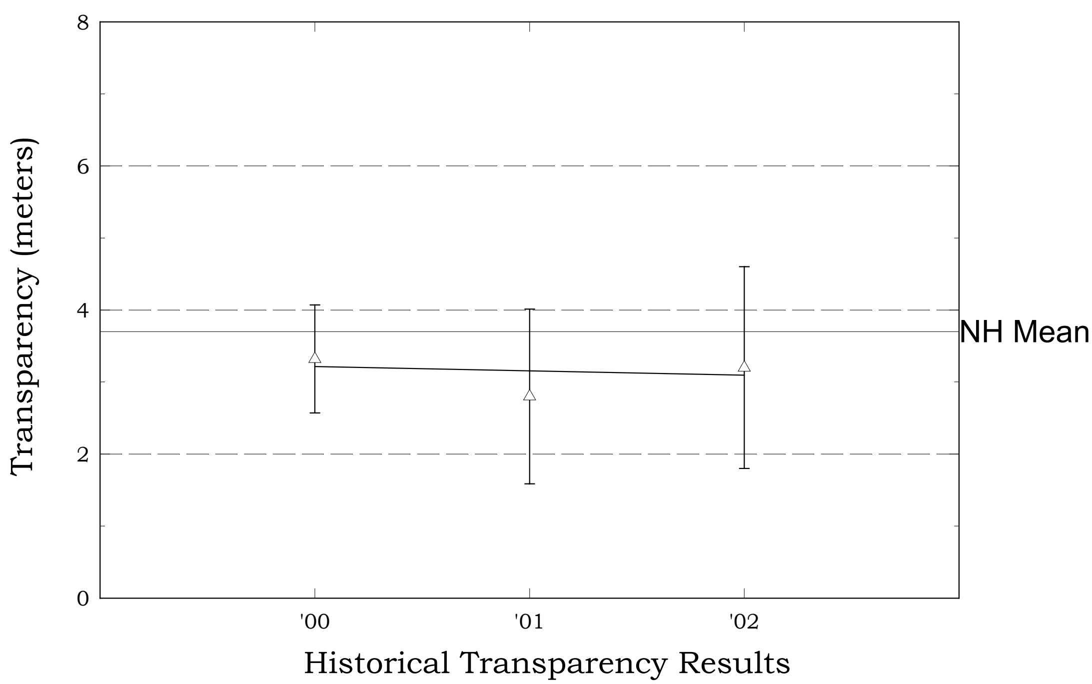




Nutts Pond, Manchester

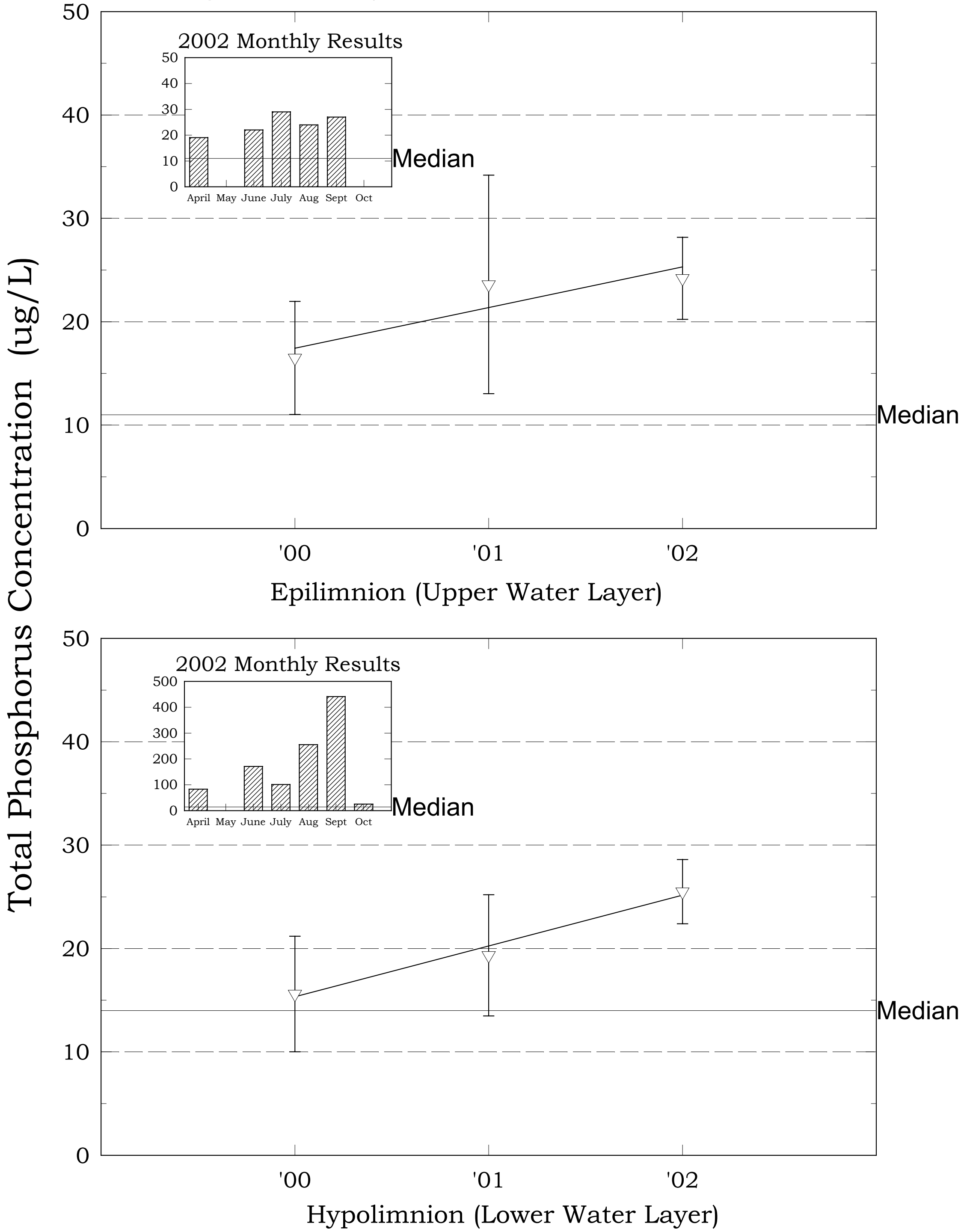
Figure 2. Monthly and Historical Transparency Results





Nutts Pond, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.



Pine Island Pond

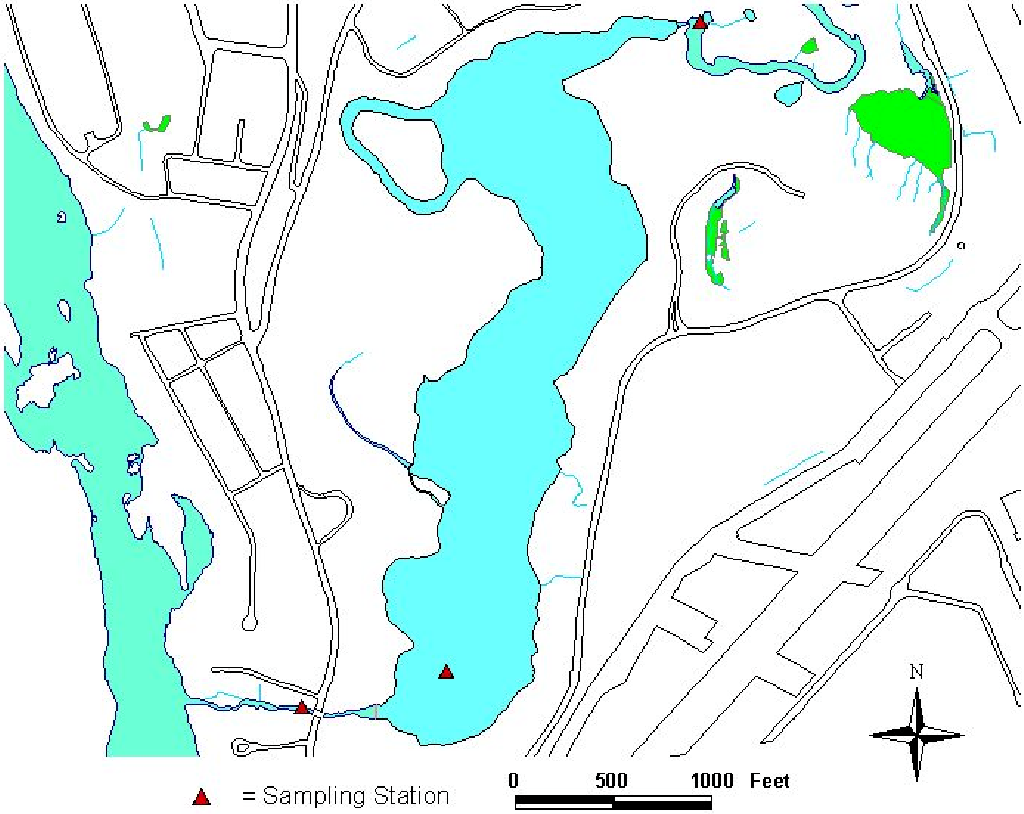


Figure 4 – Pine Island Pond Sampling Stations

Pond Location and Description

Pine Island Pond is located just west of the airport and east of Brown Avenue and abuts the Manchester Airport. It's outlet (Cohas Brook) flows under Brown Ave to the Merrimack River.

Pond Goals & Project Status

Pine Island Pond is at the most downstream point of flow for a very large watershed; the Great Cohas Brook watershed. The Pine Island Pond watershed is under increasing threat of development by airport and other commercial interests. A resident pond advocacy group is key to increasing awareness and encouraging environmentally sensitive development in this area. A dedicated group of pond area residents have recently shown an interest in forming such a group. There already exists a group dedicated to preserving and showcasing the interesting and unique historical aspects of the Goffs Falls neighborhood. These historical features include Great Cohas Brook and Pine Island Pond.

Goal(s): To maintain fishable and swimmable water quality standards and to improve fish habitat.

Water Quality:

1) Stabilize streambank at Cohas Brook.
2) Address sedimentation at Cohas Brook where it enters Pine Island Pond.

Outreach/Education:

1) Retrofit and provide educational materials in kiosk at Pine Island Park.

An Eagle-Scout will be retrofitting the kiosk at Precourt Park during May, 2003.

A series of color, laminated fact-sheets and posters has been created to be posted in the kiosks during the summer of 2003. These include a map of the waterbody/watershed, fact-sheets for water quality results, the history of the waterbody, and non-point source pollution issues, and posters on common exotic plants and common fish.

2) Address accelerated plant growth through fertilizer education to property owners.

3) Address invasive species at Cohas Brook through volunteer maintenance efforts.

4) Support other entities to address boat wake issues.

Recreational:

1) Assess feasibility of fish ladder at dam with NHFG.

Other:

1) Develop Watershed Management Plan.

Water Quality

More than just immediate water quality data is required to understand the condition of Pine Island Pond. This waterbody in particular has the potential to change very quickly with changes in the watershed. Close and careful monitoring is essential to the future health of Pine Island Pond.

Pine Island Pond water quality is still relatively good. It is still used for swimming, fishing and boating. Twenty years of increasing watershed development have impacted the pond, however. Pine Island Pond has seen a slow but steady decline in water quality over the past twenty years, but over the past three years has experienced fluctuations in water quality conditions.

Chlorophyll-*a*

Composite chlorophyll-*a* concentrations ranged from 3.89 to 14.29 mg/m^3 with an average of 8.23 mg/m^3. This is a decrease from 2001, but consistent with 2000 values.

The current year data (the top graph) show that the chlorophyll-concentration increased gradually from June to September this season.

The historical data (the bottom graph) show that the 2002 chlorophyll-a mean is slightly greater than the state mean. Overall, visual inspection of the historical data trend line (the bottom graph) shows a decreasing in-lake chlorophyll-a trend, meaning that the concentration has improved since monitoring began. We hope this trend continues! Please note that this trend is based on only three years of data.

After 10 consecutive years of sample collection for the pond, we will conduct a statistical analysis of the data. This will allow us to objectively determine if there has been a significant change in the annual mean chlorophyll-a concentration since monitoring began.

Conductivity

Conductivity values were also relatively uniform throughout the water column. The epilimnion averaged 316.1 uMhos/cm. The hypolimnion averaged 317.8 uMhos/cm. All conductivity values are high when compared to a "natural, undisturbed lake", but have not changed drastically since 1981.

Dissolved Oxygen

Dissolved oxygen concentrations were fairly stable in 2002 with steady decline as the season progressed. The lowest DO readings were recorded in September.

During the months of July, August and September, the dissolved oxygen concentration was high in the epilimnion and metalimnion (middle layer); however, the concentration in the hypolimnion (lower layer) was low. This is a sign of the pond's aging and declining health. Please refer to the Table 10 discussion for a more detailed explanation.

The dissolved oxygen concentration was low in the hypolimnion at the deep spot of the pond in July, August, and September. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the pond where the water meets the sediment.

During this season, and the past sampling seasons the pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of internal total phosphorus loading (commonly referred to as internal loading) is occurring in the pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as it was this season and in many past seasons), the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column. Depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses.

pH and Acid Neutralizing Capacity

Pine Island Pond pH values ranged from 6.50 to 7.10 and averaged 6.86. This is similar to pH values recorded in 2000 and 2001. ANC values ranged from 6.2 to 29.6, and averaged 21.18 mg of CaCO/L. These readings indicate that Pine Island Pond has substantial buffering capacity. ANC, like pH, seems to remain steady year after year.

Phosphorus

As discussed above with dissolved oxygen, an internal source of phosphorus in the pond may be present. Therefore, it is even more important that watershed residents act proactively to minimize external phosphorus loading from the watershed. For instance, picking up after pets, minimizing fertilizers on lawns, etc.

Pine Island Pond total phosphorus readings were relatively uniform throughout the water column, with the epilimnion averaging .023 mg/L and hypolimnion averaging .030 mg/L. These values are higher than those recorded in 2001, but are consistent with values recorded in 2000.

The historical data for the epilimnion (upper layer) show that the 2002 total phosphorus mean is greater than the state median. Overall, visual inspection of the historical data trend line for the epilimnion shows a variable total phosphorus trend, which means that the concentration has fluctuated in the epilimnion since monitoring began.

The historical data for the hypolimnion (lower layer) show that the 2002 total phosphorus mean is also greater than the state median. Overall, visual inspection of the historical data trend line for the hypolimnion shows a relatively stable total phosphorus trend, which means that the concentration has remained approximately the same in the hypolimnion since monitoring began.

As discussed previously, these trends are based on a limited data set.

Transparency

Secchi disk transparency dropped steadily as chlorophyll-*a* concentration increased. Transparency ranged from 1.45 to 2.3 meters and averaged 1.9 meters. Pine Island Pond has a natural tea color caused by the presence of tannins (plant pigments). This condition limits water transparency. Average Secchi disk transparency has remained consistent at 1.9 meters for the past 3 years.

The historical data (the bottom graph) show that the 2002 mean transparency is less than the state mean. Overall, visual inspection of the historical data trend line (the bottom graph) shows a variable trend for in-lake transparency, meaning that the transparency has fluctuated since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into the pond and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the pond.

Turbidity

Turbidity ranged from 1.94 to 11.80 (NTU) in the hypolimnion and averaged 6.02 (NTU). Epilimnion turbidity ranged from 1.78 to 4.87 (NTU). The peak turbidity was recorded in September, coinciding with high chlorophyll-*a* and TP readings. This pattern also occurred last year at the end of the summer season.

The turbidity of the hypolimnion (lower layer) sample was elevated on the August 28th and September 26th sampling event. This suggests that the pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column.

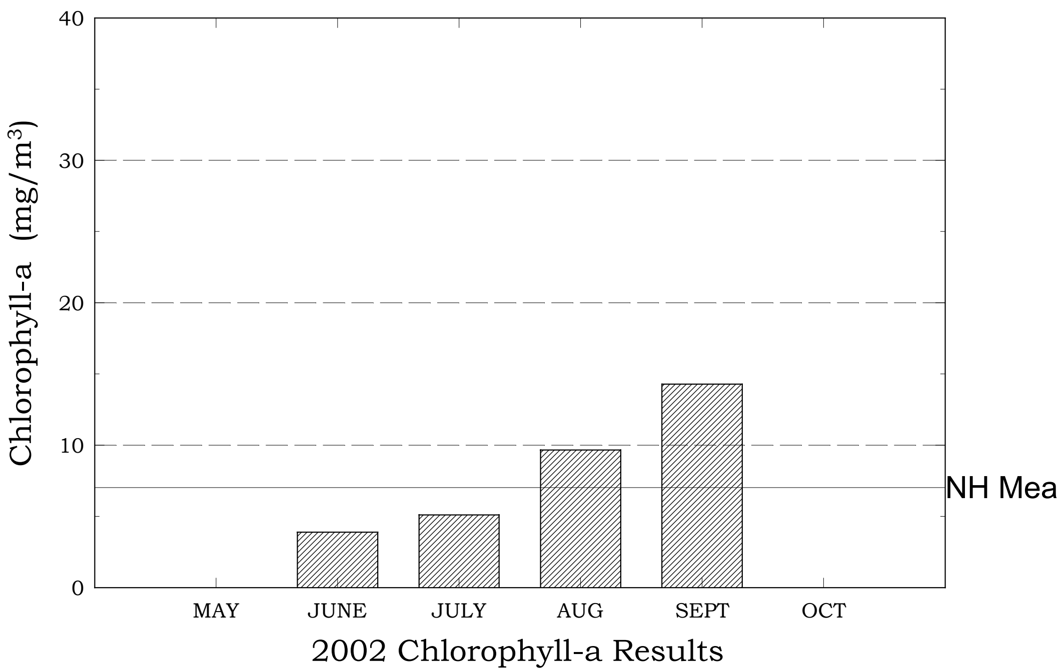
Table 7[1]
Comparison of Pine Island Pond – 1980*, 1997, 2000 & 2001**

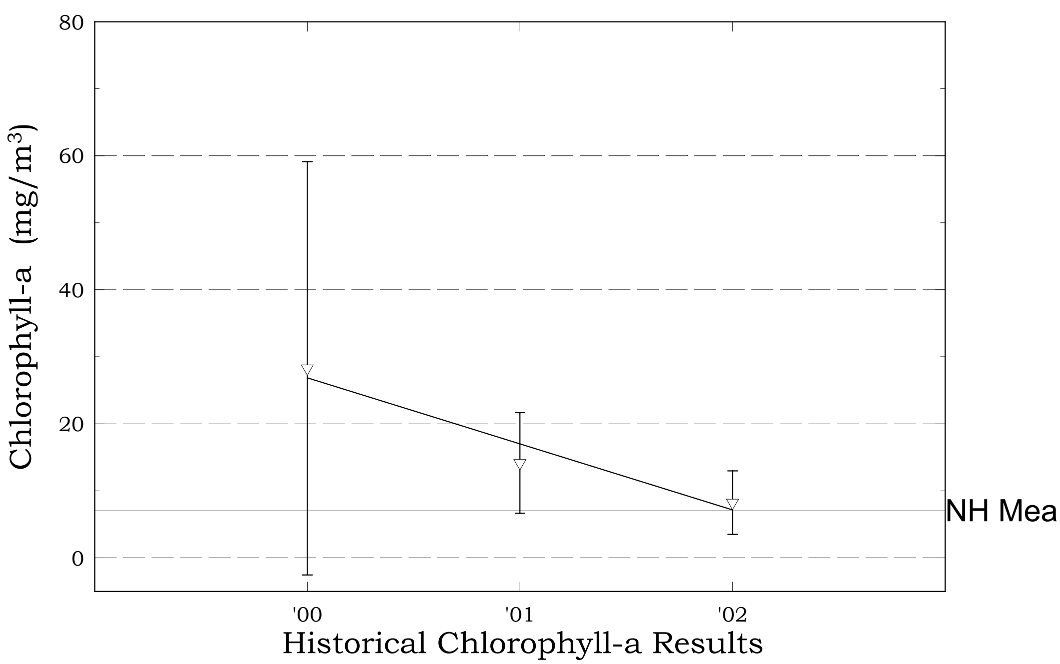
Parameter	8/5/80	7/24/97	2000 Mean	2000 Median	2001 Mean	2001 Median	2002 Mean	2002 Median
PH	7.1	7.2	6.97	7.07	7.00	7.04	6.86	6.93
Alkalinity (mg/l)	15.2	20.6	17.1	19.5	20.1	21.0	21.2	24.5
Total Phosphorus (mg/l)	0.015	0.018	0.024	0.024	0.016	0.017	0.023	0.026
Conductivity (uMhos/cm)	142.8	290.4	287.1	308.0	383.3	412.5	316.1	357.5
Secchi Disk (m)	2.0	1.4	1.9	1.9	1.9	1.7	1.9	2.0
Chlorophyll-*a* (mg/m3)			8.0	8.6	13.2	11.4	8.23	7.38

1) All values are epilimnetic. * NH Dept. of Environmental Services. 1980. Trophic Classification of NH Lakes and Pond.
** NH Dept. of Environmental Services. 1998. Lake Trophic Data.

Pine Island Pond, Manchester

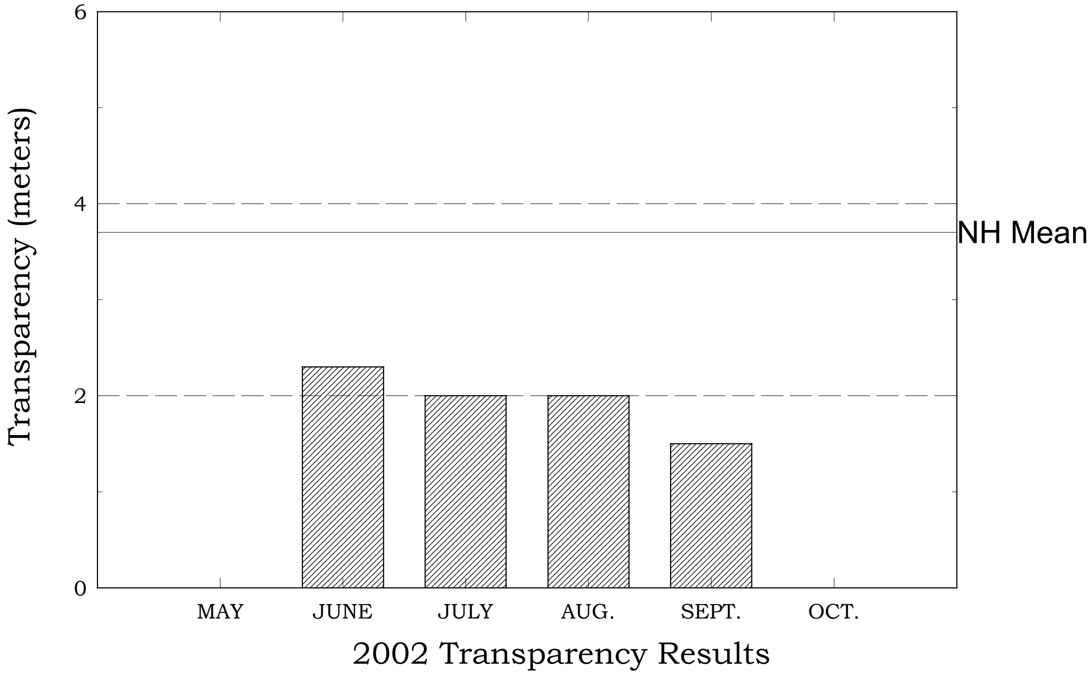
Figure 1. Monthly and Historical Chlorophyll-a Results

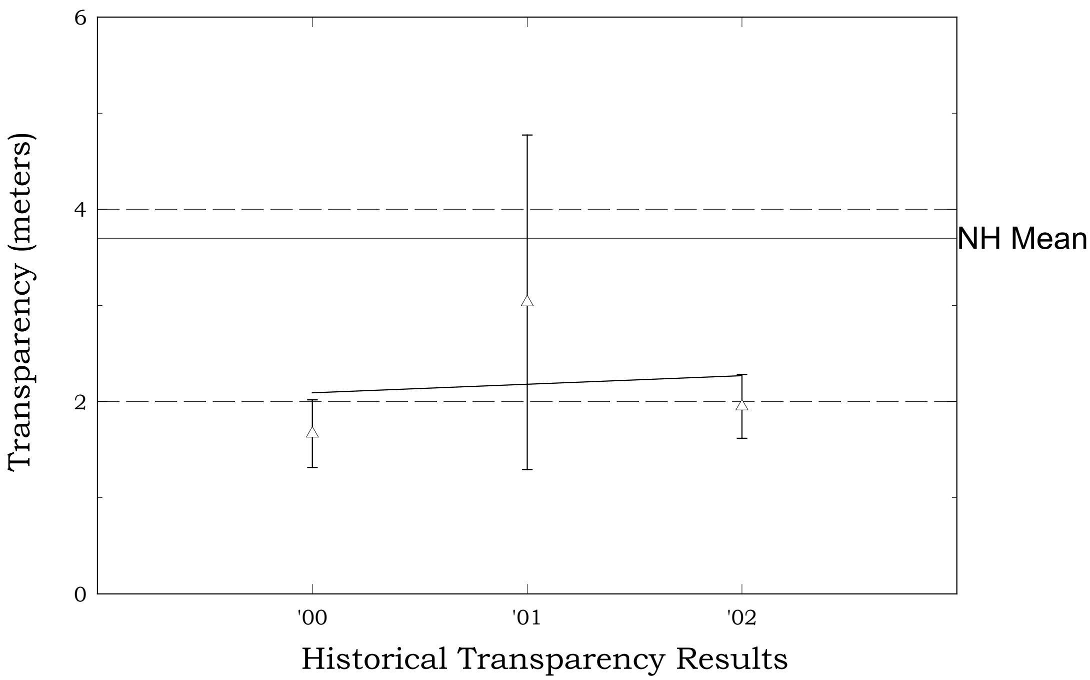




Pine Island Pond, Manchester

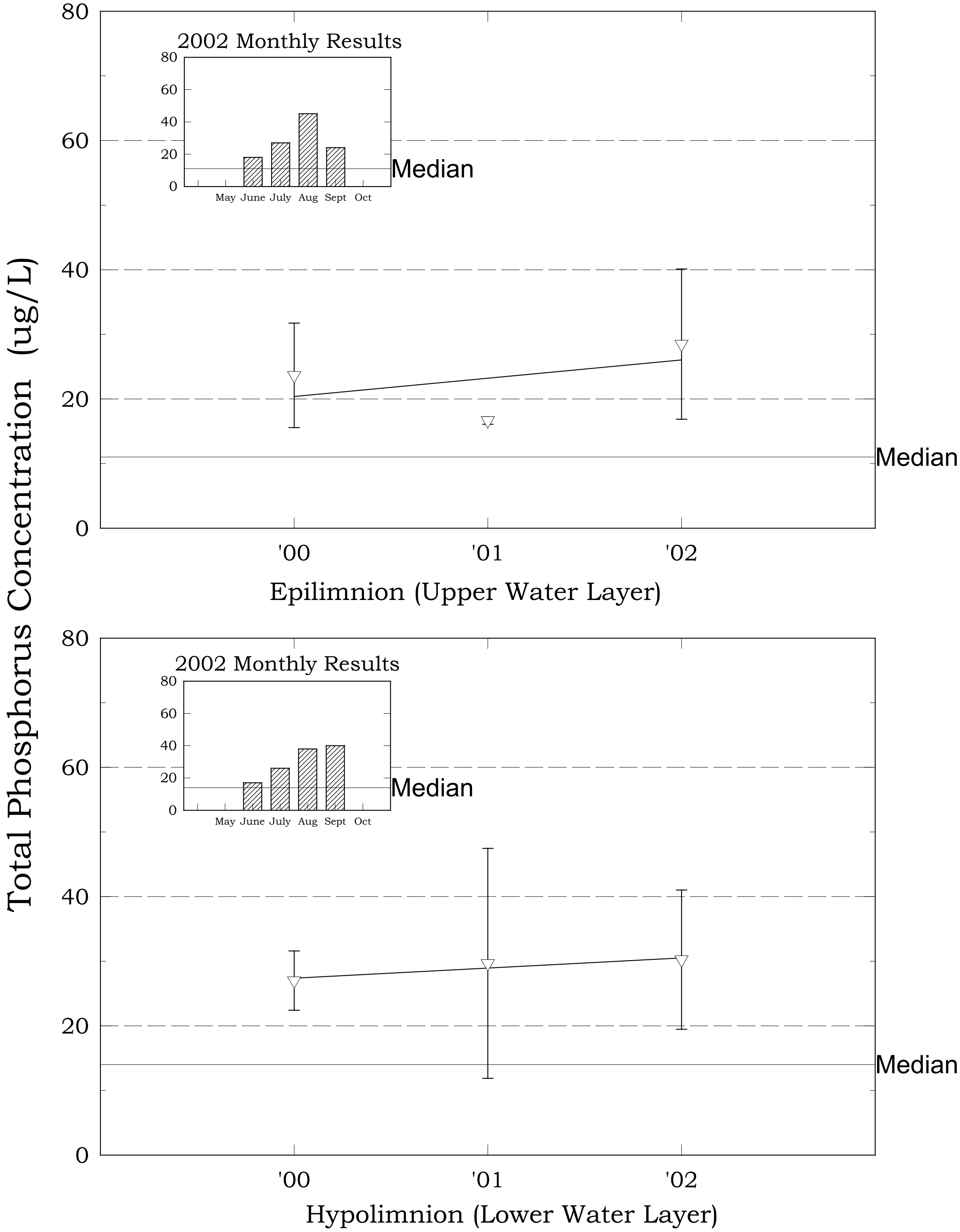
Figure 2. Monthly and Historical Transparency Results





Pine Island Pond, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.



Stevens Pond

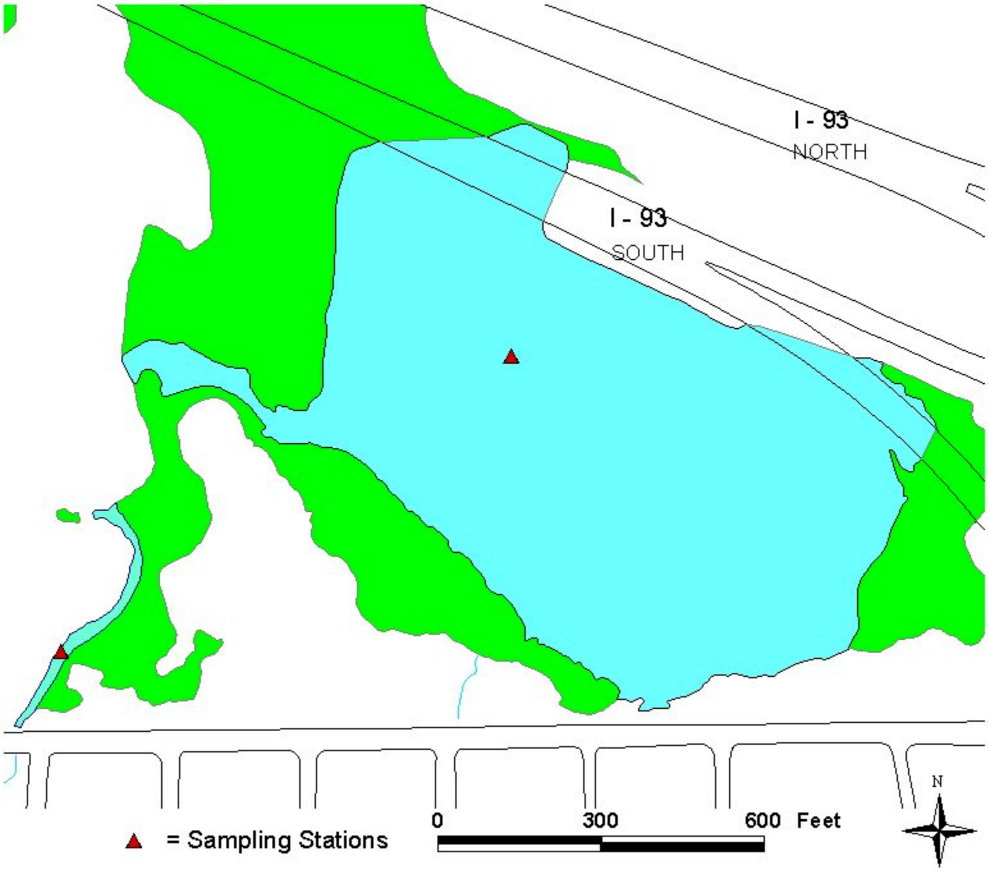


Figure 4 – Stevens Pond Sampling Stations

Pond Location and Description

Stevens Pond is located off Bridge Street Extension, under I93 near the 101 east divergence. It is commonly used for fishing and ice fishing, boating and ice skating.

Pond Goals & Project Status

Goal(s): To improve water quality through a partnership with the New Hampshire Department of Transportation to address highway runoff.

Water Quality:

1) Address and remedy I-93 runoff issues.

Since 2001, several agencies have been working on a solution to the highway runoff issue at Stevens Pond. The NH Department of Transportation has expressed willingness to work with DES and the UPRP to treat the highway runoff that is drastically affecting the water quality of Stevens Pond. Proposed solutions include a closed drainage system to divert stormwater to where adequate treatment can be attained, or a berm diversion system to separate the stormwater from Stevens Pond. Discussions with NH DOT are ongoing.

2) Address headwater erosion at EJ Roy Drive and other developed areas.

Outreach/Education:

1) Construct and provide educational materials in kiosk at boat launch.
2) Address invasive species with proper signage at kiosk and boat launch.

An Eagle-Scout will be retrofitting the kiosk at Precourt Park during May, 2003.

A series of color, laminated fact-sheets and posters has been created to be posted in the kiosks during the summer of 2003. These include a map of the waterbody/watershed, fact-sheets for water quality results, the history of the waterbody, and non-point source pollution issues, and posters on common exotic plants and common fish. In addition a public-awareness sign regarding milfoil will be posted at the boat launch.

Recreational:

1) Improve boat-launch.
2) Create wetland boardwalk
3) Improve adjacent trails.

Land Preservation:

1) Secure adjacent parkland through zoning/easements.

Water Quality

For more than 30 years, Stevens Pond has been impacted by untreated highway runoff from Interstate 93. Deicing activities and automotive byproducts have led to the serious degradation of a popular fishing and swimming spot in Manchester. Increasing residential development in the watershed is also an issue of concern.

Stevens Pond has been severely impacted by development. Eutrophication (aging of the water body, including sedimentation) is being accelerated by highway runoff. Chloride and sodium levels are among the highest ever recorded in a freshwater body in New Hampshire. Significant decline cannot be seen over the past twenty years, with the exception of conductivity levels. Stevens Pond accelerated eutrophication apparently began before documentation of conditions in 1981.

Chlorophyll-*a*

Composite chlorophyll-*a* concentrations for the upper metalimnion and epilimnion ranged from 2.21 to 25.54 and averaged 10.32 mg/m^3. This is an increase over both 2000 and 2001.

The historical data (the bottom graph) show that the 2002 chlorophyll-*a* mean is greater than the state mean. The chlorophyll-concentration was very high on the September sampling event (25.54 mg/m^3), which suggests that an algal bloom had occurred. (However, it is interesting to note that transparency in the pond on the September sampling event was not negatively affected as we would expect if an algal bloom had occurred.)

Overall, visual inspection of the historical data trend line (the bottom graph) shows an increasing in-lake chlorophyll-*a* trend, meaning that the concentration has worsened since monitoring began in 2000. However, please keep in mind that this trend is based on a limited amount of data.

Chloride

This year was the first year that the chloride concentration was measured at the deep spot of the lake. In New Hampshire, the median chloride concentration for lakes/ponds is 5 mg/L. The chloride in pond ranged from 277 mg/L in the epilimnion (top layer) to 291 mg/L in the hypolimnion (bottom layer). The increase of chloride concentration from the epilimnion to the hypolimnion may indicate the presence of a chemocline (depth below which chemicals in the pond are trapped)

Conductivity

Conductivity levels remained relatively constant throughout the season and throughout the water column with peak conductivity occurring in April. Epilimnion conductivity ranged from 924 to 1549 and averaged 1140.0 uMhos/cm. Metalimnion conductivity ranged from 930 to 1091 and averaged 1010.5 uMhos/cm. Hypolimnion conductivity ranged from 1102 to 1612 and averaged 1247.8 uMhos/cm. These numbers are similar to those recorded in 2001. These are very high readings, indicative of a very degraded water body.

The mean conductivity levels at each station continued to be very high this season (Table 6). Typically, sources of elevated conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake), and stormwater runoff from urbanized areas (which typically contains road salt during the spring snow melt). In addition, natural sources, such as iron deposits in bedrock, can influence conductivity. Due to the history and present status of this highly urbanized watershed, and proximity of I-93, the high conductivity levels in the pond are probably due to runoff from the overpass.

Dissolved Oxygen

Thermal stratification was already apparent at Stevens Pond when monitoring began in early April. Dissolved oxygen concentration was initially uniform, but declined steadily through the sampling season. DO became completely depleted in the hypolimnion. Super-saturation of dissolved oxygen was observed in the epilimnion in August. Super-saturation is a condition where the water holds greater than 100% of the expected maximum concentration of oxygen.

The dissolved oxygen concentration was low in the hypolimnion on the June, August, and September sampling events. As lakes/ponds age, oxygen becomes depleted in the hypolimnion (the lower layer) by the process of decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. Depleted oxygen concentration in the hypolimnion of thermally stratified lakes/ponds typically occurs as the summer progresses.

During this season, and the past two sampling seasons, the lake/pond has had a lower dissolved oxygen concentration and a higher total phosphorus concentration in the hypolimnion (the lower layer) than in the epilimnion (the upper layer). These data suggest that the process of internal phosphorus loading is occurring in the lake/pond. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion (as it was this season and in many past seasons), the phosphorus that is normally bound up with metals in the sediment may be re-released into the water column.

pH and Acid Neutralizing Capacity

Stevens Pond pH ranged from 6.77 to 7.17 and averaged 7.03. There was no significant change in pH between 2000 and 2001, but pH dropped slightly in 2002. ANC values ranged from 21.0 to 37.8 mg/L of CaCO. ANC averaged 30.8 mg/L of CaCO. Stevens Pond has a high buffering capacity. There was has been no significant change in ANC between since 2000.

Phosphorus

Total phosphorus levels in the hypolimnion ranged from .011 to .058 with an average of .035 mg/L. This is approximately 48% higher than 2001 hypolimnion TP levels. High TP levels in the hypolimnion may indicate internal loading. Epilimnion TP levels ranged from .014 to .024 with an average of .018 mg/L. This is a decrease from 2001, back to approximate 2000 levels.

The historical data for the epilimnion (upper layer) show that the 2002 total phosphorus mean is *greater than* the state median. Overall, visual inspection of the historical data trend line for the epilimnion shows *a stable* total phosphorus trend, which has been *greater than* the state median since monitoring began.

The historical data for the hypolimnion (lower layer) show that the 2002 total phosphorus mean is *much greater than* the state median. It is important to note that the total phosphorus concentration in the hypolimnion *increased steadily* from April to September this year. This suggests that the process of *internal phosphorus loading* is occurring in the pond (Please refer to the discussion for Table 9 and 10 for a more detailed explanation.)

Overall, visual inspection of the historical data trend line for the hypolimnion shows *a stable* (i.e. not changing) total phosphorus trend, which has been *much greater than* the state median since monitoring began.

Transparency

Secchi disk readings ranged from 2.6 to 3.4 and averaged 2.95 meters. Transparency did not appear to be greatly affected by chlorophyll-*a* content.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a slightly increasing (meaning improving) trend for in-lake transparency since monitoring began in 2000.

As discussed previously, after at least 10 consecutive years of sample collection, we will conduct a statistical analysis of the data to objectively determine long-term trends in lake quality.

Turbidity

As expected, Stevens Pond turbidity values were highest in the hypolimnion (bottom layer). This may be caused by high levels of sodium and chloride in the bottom sediments. Hypolimnion turbidity ranged from 2.52 to 40.5 with an average of 15.24 (NTU). Epilimnion (top layer) and metalimnion (middle layer) turbidity values averaged 2.45 and 2.88 respectively. These are the highest turbidity levels recorded at Stevens Pond since sampling began in 2000.

The turbidity of the hypolimnion (lower layer) sample was elevated on the August sampling event (40.5 NTUs). This suggests that the lake/pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling. When the lake/pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column.

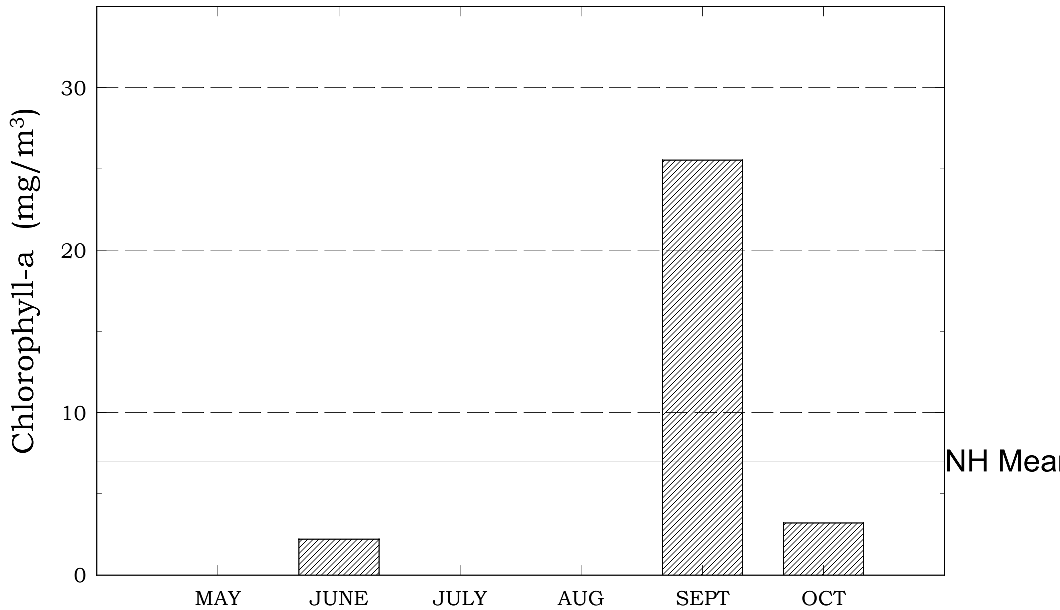
Table 8[1]
Comparison of Stevens Pond – 1981*, 1997, 2000 - 2002**

Parameter	7/29/81	7/23/97	2000 Mean	2000 Median	2001 Mean	2001 Median	2002 Mean	2002 Median
pH	7.2	7.7	7.11	7.15	7.14	7.20	7.03	7.10
Alkalinity (mg/l)	33.0	31.8	34.2	34.8	31.0	32.7	30.78	31.4
Total Phosphorus (mg/l)	0.028	0.028	0.019	0.019	0.025	0.028	0.018	0.018
Conductivity (uMhos/cm)	301	696	769	765.5	1148.8	1128.0	1140.0	1102.0
Secchi Disk (m)	2.0	1.3	2.6	2.6	2.5	2.6	3.0	2.9
Chlorophyll-*a* (mg/m3)			8.68	4.08	6.26	4.60	10.32	3.20

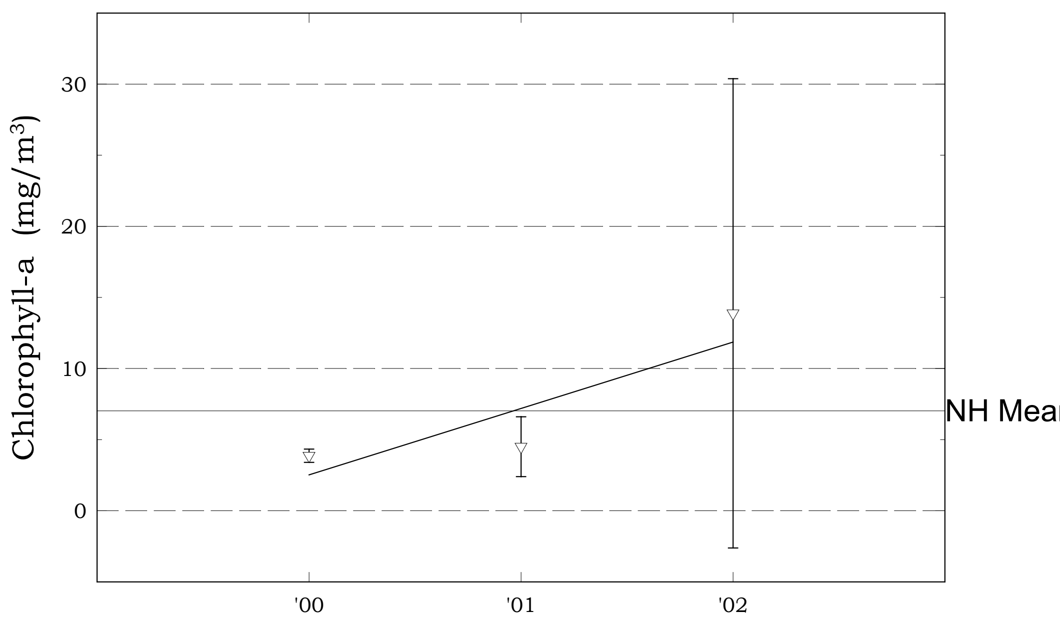
1) All values are epilimnetic.
* NH Dept. of Environmental Services. 1981. Trophic Classification of NH Lakes and Ponds.
** NH Dept. of Environmental Services. 1998. Lake Trophic Data.

Stevens Pond, Manchester

Figure 1. Monthly and Historical Chlorophyll-a Results



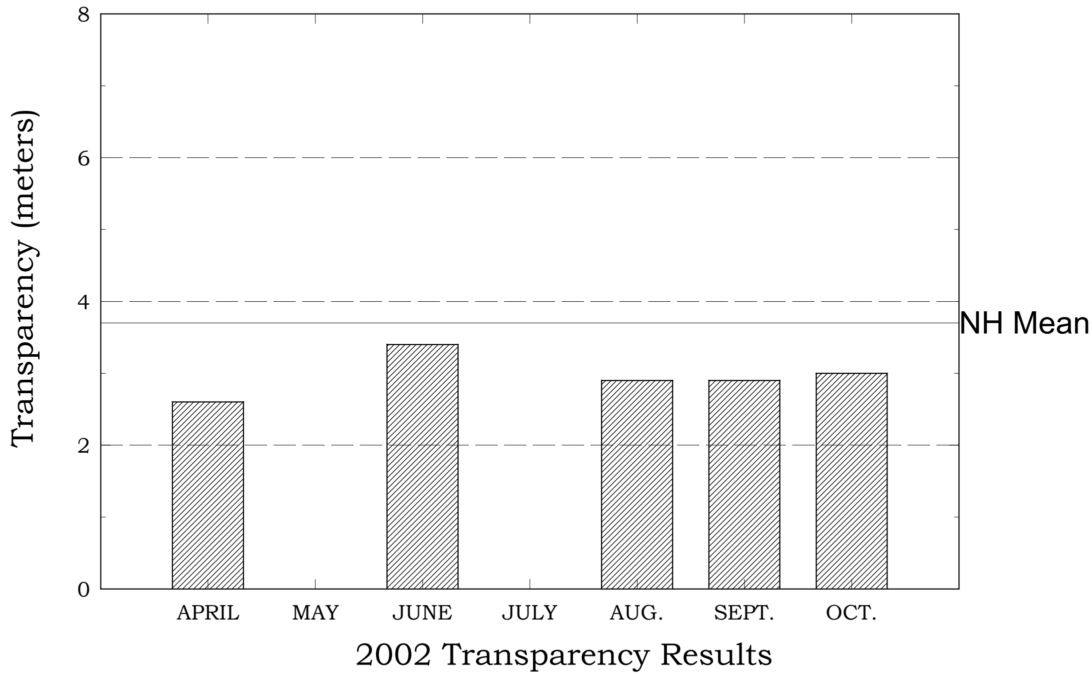
2002 Chlorophyll-a Results

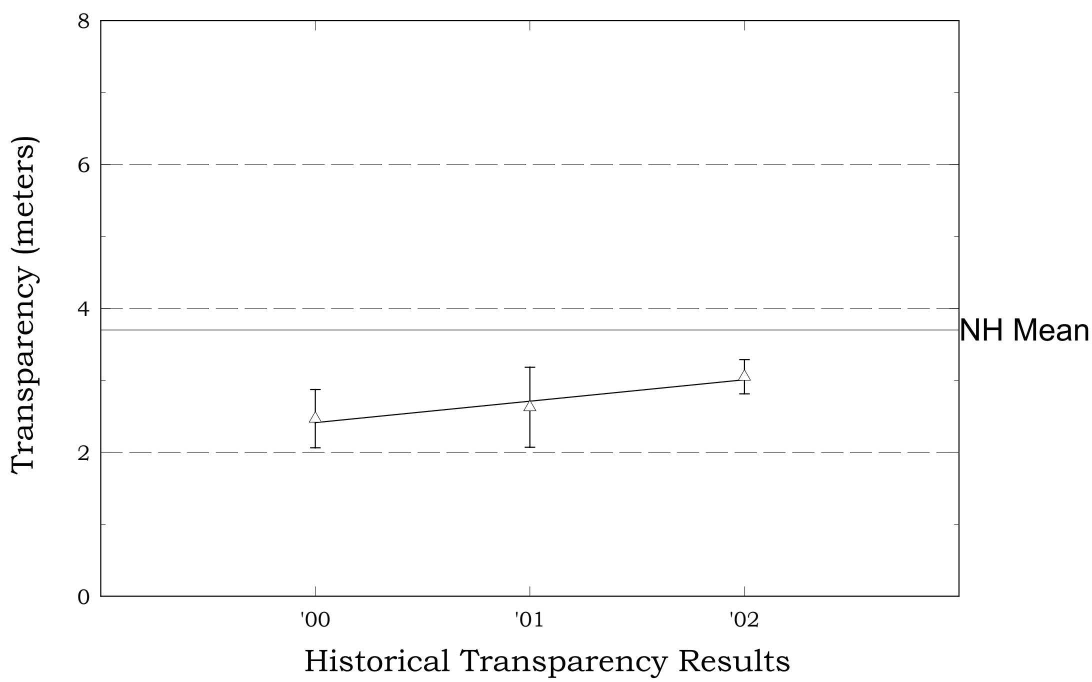


Historical Chlorophyll-a Results

Stevens Pond, Manchester

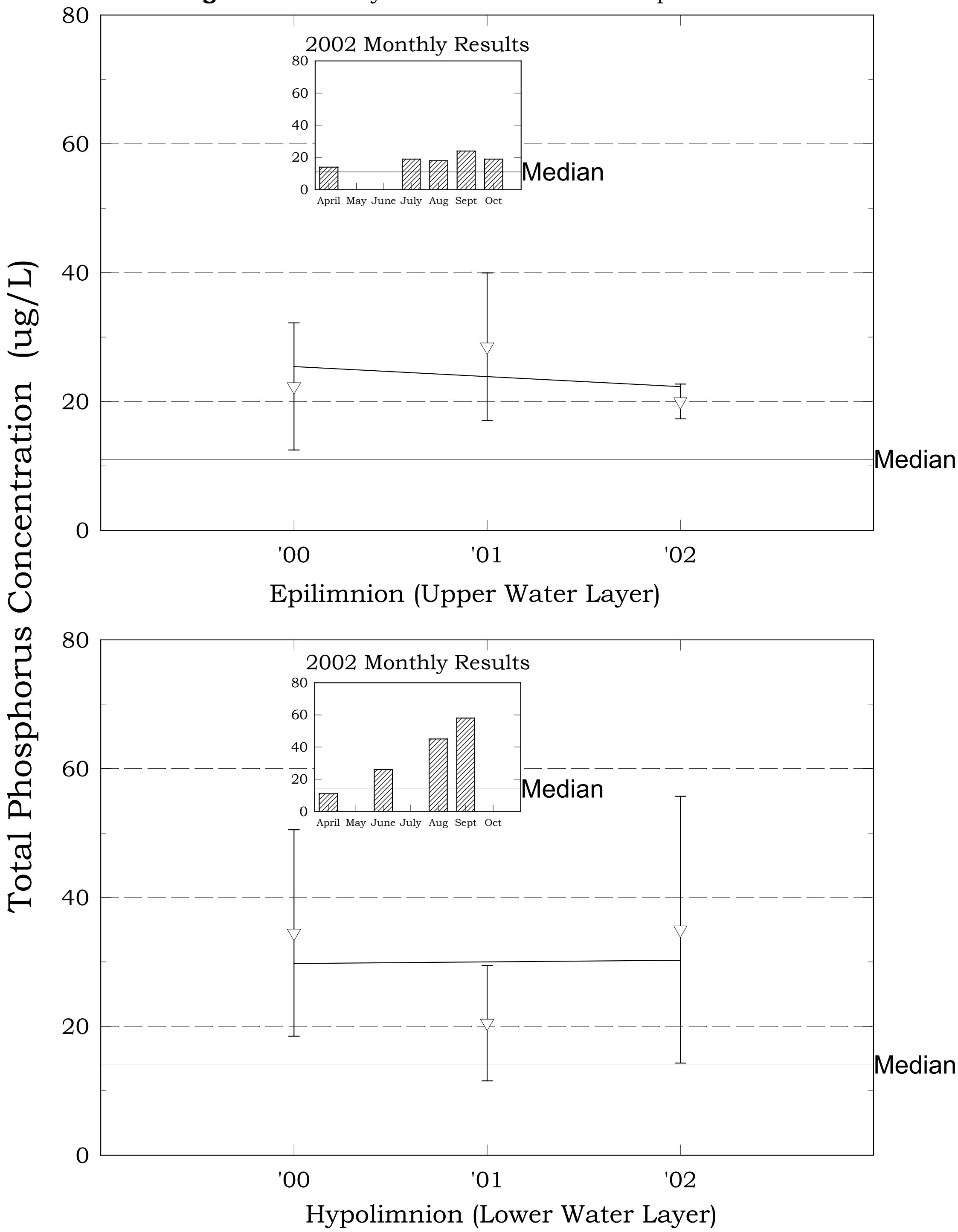
Figure 2. Monthly and Historical Transparency Results





Stevens Pond, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.



Appendix A.
Fact-Sheets, Newsletter, Posters, & Surveys

Manchester Urban Ponds Restoration Program

One City Hall Plaza – Manchester NH 03103
(603) 624-6450
http://www.ci.manchester.nh.us/UrbanPonds

MAXWELL POND DAM REMOVAL: RESTORATION OF BLACK BROOK IS FEASIBLE

HISTORY OF MAXWELL POND

Maxwell Pond, located on Front Street south of Dunbarton Road in Manchester, was created by the installation of a dam on Black Brook in 1900. The pond was reportedly named for A.H. Maxwell, who owned the Manchester Coal & Ice Company at the time when ice was harvested there. Ice harvesting took place in the 1930's and '40's, when Maxwell Pond was considered the best source in Manchester for pure ice. The company was located adjacent to the pond and would keep the ice cold with hay-bales and sell it year round.

Until the late 1950's, Maxwell Pond was a popular place for swimming, picnicking, and fishing in the summer. In the winter months the pond provided a spot for skating, bonfires and hockey games. It was even considered for a secondary municipal water source for the City of Manchester, but the idea was apparently abandoned sometime in the 1960's. In the late 1950's and early 1960's Maxwell Pond began to change when a cement company located upstream began impacting Black Brook by washing sediment into the streambed and impoundment. Today the dam is owned by the City and maintained by the Manchester Parks and Recreation Department. There is a small playground near the dam. The pond hosts educational programs sponsored by the Audubon Society through the Amoskeag Fishways.

WHY REMOVE DAMS?

There are more than 4,800 active and inactive dams in the State of New Hampshire. Many of these dams were built during the Industrial Revolution in the 19th and early 20th centuries, and they played central roles in New Hampshire's economic and societal growth during that period. But as technological and societal needs have changed, so too has the need for some dams.

Many New Hampshire dams and their impoundments enable and enhance values recreational uses, such as boating, fishing, and swimming. A smaller number of New Hampshire's dams provide important services such as water supply and flood control. But some dams, particularly those that are old, unsafe and uneconomical, may be good candidates to consider for removal.

BENEFITS OF SELECTIVE DAM REMOVAL

- Elimination of a public safety hazard.
- Cost savings to taxpayers and dam owners.
- Improvement to water quality.
- Elimination of barriers to fish and other aquatic species.
- Restoration of river habitats.
- Creation of new, river-based recreational opportunities.

Dams were historically built with little, if any, consideration to their impact on river systems. In the last several decades, resource managers have learned that dams cause environmental damage, that free-flowing rivers play a vital role in ecosystem health, and that selective dam removal can be both efficient and effective.

Selective dam removal can eliminate a public safety hazard, relieve a dam owner's financial and legal burdens and restore a river to a healthier, free-flowing condition. Consequently, some dam owners are taking a second look at their dams.

WHY REMOVE MAXWELL POND DAM?

Over the last 40-50 years, residents have not been able to swim in Maxwell Pond due to increases in sediment load from upstream sites over time. Today, the pond (which had a maximum depth of 8 feet in 1954) has a maximum depth of just 4 feet. Clearly the land uses upstream have had an impact on Maxwell Pond**,** and historical activities have not taken place at the pond in many decades.

The possibility of restoring Black Brook as a free-flowing river by removing the Maxwell Pond dam came about as one of several corridor-wide projects aimed at restoring different reaches of Black Brook. These projects include riparian/wetland work upstream from Maxwell Pond near the City's transfer station and brook restoration planning further upstream near Wakefield Materials. Removal of the dam at the mouth of the river would complement these activities and could be accomplished as part of the overall restoration effort at no cost to the City.

WHAT ARE THE FACTORS OF DAM REMOVAL?

The process of selective dam removal looks at several factors such as possible wetland impacts, fish and wildlife impacts, social impacts, water quality and quantity impacts, historical resource impacts, sedimentation impacts, floodplain impacts, and aesthetic impacts. It is the **environmental issues** that often trigger consideration for dam removal, but it is typically the **economic issues** that are the pivotal decision factor since it is, in many cases, less expensive to remove a dam than to maintain and repair it on a yearly basis. While **engineering** issues are typically straightforward, it is the **social issues** that tend to be the most challenging aspect of dam removal.

ENVIRONMENTAL ISSUES

Dams can have many ecological impacts on rivers. They can block fish and other aquatic species from moving throughout a river system to access spawning sites and other critical habitats. Dams can hold back and cause buildup of sediment, woody debris, and other materials that naturally would have been disturbed throughout the river and would have played important roles in providing nutrients and habitat for plants and animals downstream. Dams can increase water temperatures and decrease the availability of dissolved oxygen in impoundments, forcing many native river species out because they can't live under those conditions. Dams can also flood wetlands, floodplain forests and other ecosystems that naturally occur along the river's edge and serve valuable purposes.

The act of removing a dam may seem like a radical event to a river and the species that live in it, but rivers have proven themselves to be very resilient and able to "heal" quickly, based upon many dam removals that have taken place nationwide. Previously submerged lands revegetate rapidly, typically within a few weeks during the growing season. Fish populations and species diversity commonly increase in the restored stretch of the river within the first year after a dam is removed. Significant water quality improvements are often seen in a similarly short amount of time, depending upon conditions.

ECONOMIC ISSUES

The cost of keeping a dam safe, particularly when the dam is no longer serving an economic function, can represent a significant burden to the dam owner. Dam ownership requires ongoing financial responsibility. Sometimes the costs of operation and maintenance, liability protection, annual registration fees and other obligations of dam ownership outweigh the benefits derived from the dam. Studies show that repairing a dam often can cost three times more than removing that dam. In addition, today there are many potential funding sources for dam removal. In the case of Maxwell Pond, funding sources available to the City of Manchester include the Manchester Urban Ponds Restoration Program (UPRP), NH Department of Environmental Services (DES), NH Fish & Game Department (NHFG), and Trout Unlimited (TU) among others. There would most likely be no cost to the City for removing the dam.

SOCIAL ISSUES

Residents often have concerns regarding dam removal, such as “will the river/waterbody disappear?” “Will flooding occur?” or, “Will all the fish die?” Some concerns are based on lack of information while others are value-based. Many people share both sets of concerns. However, proactive discussion rather than reactive decisions typically result in creative solutions.

WHAT PRE-RESTORATION WORK HAS BEEN COMPLETED AT MAXWELL POND?

During the Winter of 2001, DES and UPRP dug 310 holes in Maxwell Pond to examine sediment depth and locate the original brook channel. Sediment chemistry was examined, and no contaminants were found. TU has been involved with surveying and aerial topographical mapping to examine channel morphology. DES, NHFG, and TU also collected fish at four sites on Black Brook (two upstream from the impoundment and two downstream) to survey species diversity, total population, weight, and lengths of the fish. At these same sites, macroinvertebrates (stream insects) were surveyed. Additional pre-restoration work (to be completed Summer 2003) will include a survey of fish inside the impoundment and additional channel cross-section work.

NEXT STEPS

The decision whether to pursue dam removal at Maxwell Pond rests with the Mayor and Board of Alderman (MBA). Members of the Conservation Commission, Manchester Department of Parks and Recreation, UPRP, Audubon Society, and interested residents have formed the Black Brook Advisory Committee (BBAC), and have met with NHDES to explore the implications of removing the dam. The BBAC is working with Alderman Armand Forest and other affected City departments to inform them and to get their perspectives. The committee will share findings and recommendations with the MBA and help to answer questions they may raise. In order to secure funding, it would be desirable for the MBA to consider this issue over the course of spring 2003.

FOR MORE INFORMATION

Steve Landry: NH Department of Environmental Services Merrimack Watershed Supervisor at (603) 271-3406 or e-mail slandry@des.state.nh.us

Art Grindle: Manchester Urban Ponds Restoration Program Coordinator at (603) 624-6450 or agrindle@ci.manchester.nh.us

Manchester Urban Ponds Restoration Program

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Have You Seen This Reed?
Common Reed (*Phragmites australis*)

Is Common Reed Too Common?

Although common reed is a native European grass, it has made its way into the United States and is considered an "invasive species." Invasive species do not have any natural predators on this continent to keep their population in check. Therefore, they have the ability to out-compete native vegetation and form dense stands.

What Does Common Reed Look Like?

Common reed has erect stems that grow up to 15 feet high and end in dense floral heads. These floral heads are purplish when young, and white or light brown and feathery when mature. Common reed's sharp, long, pointed green leaves grow up to 2 feet long and 2 inches wide. It flowers from late July through October and can be found throughout southern Canada and the United States.

Why Does Common Reed Grow So Quickly?

Stands of common reed disperse seeds, or pieces of underground stems, called rhizomes. Once established, stands grow predominately by sending up new shoots each spring from existing rhizomes, or from runners, called stolons. If an aerial shoot is knocked over, it can act like a rhizome, taking root and producing new shoots. This grass can return year after year, and some stands are believed to be 1,000 years old.

Where Does Common Reed Grow?

Common reed grows in sunny, wetland habitats. It is found in fresh and alkaline marshes, pond margins, swamps, and ditches. Not only does it thrive in freshwater habitats but it can tolerate brackish waters as well. It is prevalent in wet areas that have disturbed or polluted soils. Human activities such as road and housing development have made the invasion of common reed quite successful in adjacent wetland areas.

Why Should I Care About Common Reed?

- Common reed can tolerate a range of environmental conditions. It spreads quickly to a new area by sprouting from its underground rhizomes, or from seed. Its rhizomes spread horizontally during the growing season. During the winter, the leaves die and fall off, with only the dead brown vertical shoots remaining.
- The accumulation of dead leaves, stems, and rhizomes can prohibit the growth of native, more

desirable wetland plant species (such as cattail, rushes, and reeds).

- Common reed does not have any natural predators on this continent to control its population. Therefore, it has the ability to compete with native vegetation and form dense stands.
- Common reed germinates quickly, thereby reducing habitat size and displacing native wildlife.
- Common reed has little food value to native wildlife. Recent studies have shown that marsh fish do not reproduce in stands of common reed.
- Because of its hollow structure and abundant plant material, common reed is also an extreme fire risk. Past fire history has shown that a *Phragmites* fire is a fast-moving hot fire that can engulf adjacent structures. The plants dry easily, burn with extreme intensity, and can accelerate fire travel.

What Can Be Done To Prevent The Spread Of Common Reed?

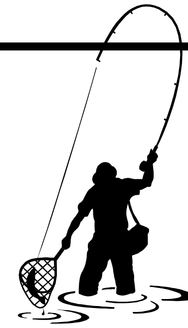
Minimizing land disturbances, implementing erosion control measures, and monitoring fluctuating water and nutrient levels adjacent to wetlands helps to prevent the spread of common reed. However, once common reed has established itself in a wetland, it is extremely difficult to eradicate. Maintaining healthy wetland ecosystems and employing best management practices will help curb this invasive, exotic species from destroying the remaining wetlands in New Hampshire, and elsewhere.

Another eradication option is the EPA-registered herbicide, glyphosate, (trade name Rodeo). The potential water quality impacts of applying glyphosphate are minimal. Tests reveal that it is virtually non-toxic to all aquatic animals. It biodegrades quickly and completely into natural products including carbon dioxide, nitrogen, phosphate, and water. Studies show it can be used without posing unreasonable risks to people or the environment. It is most effective when applied in the early fall when nutrients are displaced from the leaves and stems for storage in rhizomes. A permit from the Department of Agriculture is required to purchase and/or use Rodeo in New Hampshire wetlands.

In the winter, dead stands can be cleared by cutting/mulching to open the area for desired species. The process usually needs to be repeated in the second year to reduce the number of remaining plants, and repeated every three to five years after that. In any case, there is no easy solution to control this invasive species.

For more information, contact the Manchester Urban Ponds Restoration Program at (603) 624-6540 or e-mail agrindle@ci.manchester.nh.us.

Manchester Urban Ponds Restoration Program



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Glyphosate Facts

What is Glyphosate?

Glyphosate, or "Rodeo," is among the most widely herbicide. As an herbicide, it is registered for use on many food and non-food field crops as well as non-crop areas where total vegetation control is desired. When applied at lower rates, glyphosate is also a plant growth regulator.

With *Phragmites* (common reed), Glyphosate control is most effective in early fall when nutrients are displaced from the leaves and stems for storage in rhizomes. In the winter, dead stands can be cleared by controlled fire or cutting/mulching to open the area for desired species. The process usually needs to be repeated in the second year to reduce the number of remaining plants, and repeated every three to five years after that. Mechanical cutting of *Phragmites* and efforts with black plastic have been successful. A permit from the Department of Agriculture is required to purchase and/or use glyphosate in New Hampshire wetlands.

Is it Harmful?

Glyphosphate is of relatively low oral and dermal toxicity. Tests reveal that it is virtually non-toxic to aquatic animals. It biodegrades quickly into carbon dioxide, nitrogen, phosphate, and water. Studies also show it is safe for people and the environment.

Pesticide Registration

All pesticides sold or distributed in the United States must be registered by the Environmental Protection Agency (EPA), to ensure they can be used safely. Because of advances in scientific knowledge, the law requires that pesticides which were registered years ago must be re-registered to ensure that they meet today's stringent standards.

In evaluating pesticides for re-registration, EPA obtains and reviews a complete set of studies from pesticide producers describing the human health and environmental effects of each pesticide. EPA imposes any regulatory controls that are needed to efficiently manage each pesticide's risks. EPA then re-registers pesticides that can be used without posing unreasonable risks to human health or the environment.

For More Information

For more information about EPA's pesticide re-registration program, or glyphosate, please contact the Special Review and Re-registration Division, EPA, Washington DC at (703) 308-8000. For information about the health effects of pesticides, or for assistance in recognizing and managing pesticide poisoning, contact the National Pesticides Telecommunications Network at 1-800-858-7378.

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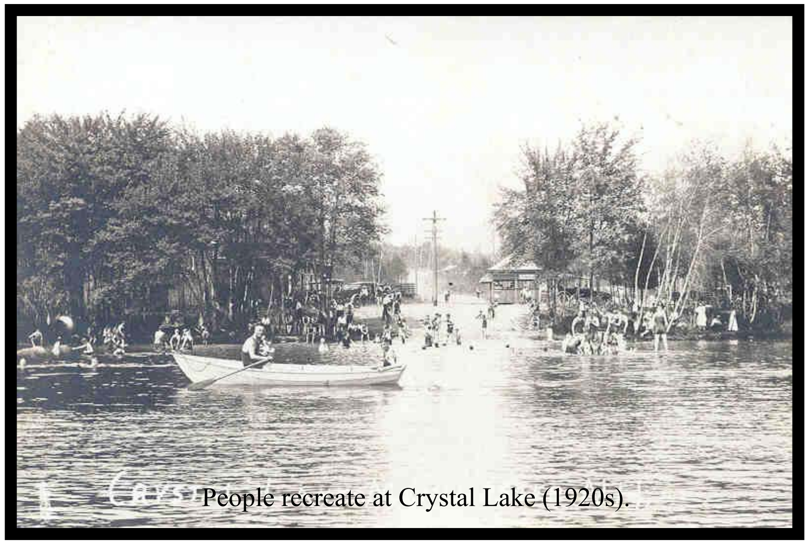
The History of Crystal Lake

"For years a popular resort for swimmers the lakefront has experienced an annual increase in the numbers of visitors and last summer soldiers from the Manchester Air Base taxed the facilities." (Union Leader, 1942)

Crystal Lake is one of Manchester's most beautiful urban ponds. Once known as Skenker's Pond and later as Mosquito Pond, it occupies approximately 19 acres in Manchester's south end. Crystal Lake park provides a swimming beach and picnicking facilities. Camps and houses surround most of the pond, except for the southwestern end where wetlands prevail.



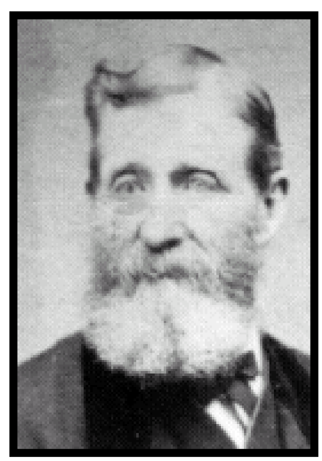
People recreate at Crystal Lake (1920s).

The Pond and Park

Before the early twentieth century, not much is recorded about the pond's history. In 1919, the City of Manchester created a municipal bathing area on 19 acres at the pond's north end. This consisted of a bath house and picnic grounds near the beach (Connor, et. al., 1985). This area was used for city-sponsored swim meets in the 1920's for Manchester children (Manchester Park, Common and Playground Comm., 1929). Due to the area's popularity, "the accommodations at Crystal Lake (were) entirely inadequate, and the bathhouse (needed to) be enlarged." (Manchester Park, Common and Playground Comm., 1928). A new bathhouse with modern improvements for an estimated 1,500 bathers was constructed and the beach was extended in 1942 by the Works Progress Administration (Union Leader, 1942). In 1987, the fieldstone-constructed bathhouse underwent a renovation sponsored by the City Parks and Recreation Department (Union Leader, 1987) and still stands at the site today.

The Hermit of Mosquito Pond

A local story tells of a man known as "the hermit of Mosquito Pond" who lived self-sufficiently near Crystal Lake. Charles Lambert came to Manchester in the 1840's and after a number of heartbreaks retreated to the woods to live a life of quiet solitude. He purchase approximately 40 acres near Crystal Lake and built his own hut using logs and old lumber that remained on the property from prior uses. He grew most of his own food and traded with local apothecaries with his home-grown herbs. Over the years his hermit lifestyle made him into a kind of local celebrity, and he became the object of many a curiosity seeker. In spite of his choice of a reclusive life, hundreds of people would visit him in the summer months (Perreault, 1984).



Mr. Lambert lived at his hermit homestead for over 60 years, spending the last two years of his life with the Sisters of Mercy at the House of St. John for aged men. He past away in 1914 and his body now lies in St. Joseph's Cemetery marked by a plain white tombstone, inscribed "The Hermit" (Perreault, 1984).

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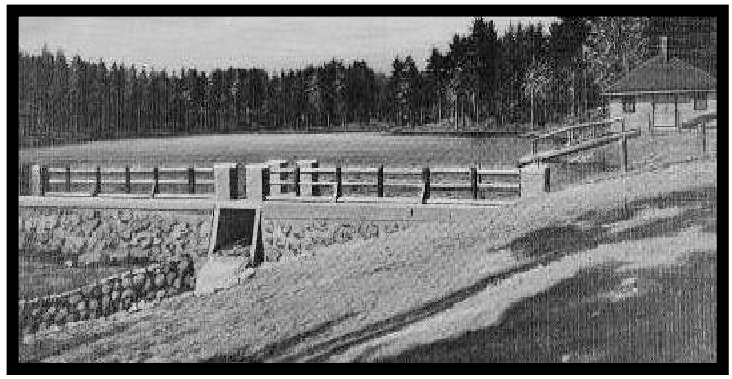
The History of Dorrs Pond



The history of Dorrs Pond dates back to the days of Manchester's early settlers. It has played host to many activities over the decades, both utilitarian, and recreational. Many of these activities have taken their toll on the pond's ecosystem. Though a thriving, natural freshwater ecosystem exists there today, it is an artificial pond first created to serve the people of Manchester (or Derryfield at the time).

In 1736, Archibald Stark moved to what is now Manchester from Londonderry and settled on the Thaxter grant near Amoskeag Falls. After his death in 1758, his property was divided among his four sons, one of whom was John Stark - the future Revoluntionary War hero (Rowell, 1904). The parcel of land that John inherited encompassed the area of Ray Brook and what is now Dorrs Pond. It was on Ray Brook that John Stark ran a sawmill for many years, presumably put there by his father.

Various historical accounts say that Stark was working at the Ray Brook mill when he heard of the fight at Lexington in April of 1775 (Willey, 1896). General Stark immediately left to fight the British and went on to become one of the leading figures of the Revolutionary War. The sawmill was apparently abandoned during the years of the War, and the remains of the dam at the sawmill site could be seen during low water until at least the late 1890's.

Sometime in the mid-1800's, George Horace Dorr, a successful realtor and auctioneer, bought the property. In 1862 Ray Brook was dammed, creating an artificial impoundment which was to become Dorrs Pond. Beginning in 1863, ice was harvested here in the winter for sale to the people of Manchester. At the time there existed a 100-foot by 60-foot ice house on the property, and the business supported 22 workers (Seney, 1998). It is also reported that when circuses came to Manchester during this period, elephants where taken to Dorrs Pond to wash and cool down (Seney, 1998).

Early in the twentieth century, the property had come to belong to the Amoskeag Manufacturing Company. Amoskeag removed the dam and drained the pond, ironically due to its biological richness and what the company called "nuisance" sport fishing for the state-stocked German carp (Weigler, 1983). In 1923, Amoskeag deeded the property to the city for conversion into a summer swimming area. The dam was reconstructed to raise the water level, bath houses were built, and sand was hauled in to create a beach. After these developments, recreational use of the pond increased to such a point that the Beech Street trolley was extended to transport the hundreds of beach-goers.

After 1936 however, use of Dorrs Pond as a swimming hole dropped off drastically. The Livingston Park pool was completed in that year, and it became the destination of choice for swimmers on hot summer days (Weigler, 1983). Today the pond and its surrounding woods provide a pocket of natural beauty in Manchester's urban environment. It still attracts many nature lovers, but plenty of trouble-makers as well. The secluded nature of the park seems to be a double-edged sword. It provides escape for those seeking relief from asphalt and concrete, but also presents opportunities for less wholesome activities. As restoration efforts move forward, historic uses may once again be the rule instead of the exception.

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The History of Maxwell Pond

Maxwell Pond, like the six other urban ponds, has been an essential part of Manchester's long history. Both recreational and occupational uses have flourished here in decades past. Recorded accounts of Maxwell Pond's history are few and difficult to locate, but much of the pond's history lives in the hearts and memories of those living in surrounding neighborhoods.

Fishing at Maxwell Pond

Maxwell Pond was created by the installation of a dam on Black Brook in 1900. In 1954, a NH Fish and Game Department survey noted that the pond contained only warm water fish species, such as: chain pickerel, horned pout and sunfish, but was a marginal salmonid water body. There are reports, however, of fishermen catching trout here and especially upstream in Black Brook where conditions most likely would have been ideal for a trout fishery.

Historical Uses

Maxwell Pond was reportedly named for A.H. Maxwell, who owned the Manchester Coal & Ice Company at the time ice was harvested there. Ice harvesting took place in the 1930's and '40's, when Maxwell Pond was considered the best source in Manchester for pure ice. The company, located upstream, would keep the ice cold with haybales and sell it year round (Drociak, 2000).

Until the late 1950's, Maxwell Pond was a popular for swimming, picnicking, and fishing in the summer. In the winter months the pond provided a spot for skating, bonfires and hockey games. It was even considered for a secondary municipal water source for the City of Manchester, but the idea was apparently abandoned sometime in the 1960's. In the late 1950's and early 1960's Maxwell Pond began to change when a cement company located upstream began impacting Black Brook by washing sediment into the streambed.

Today, the pond (which had a maximum depth of 8 feet in 1954) has a maximum depth of just 4 feet. Clearly the land uses upstream have had an impact on Maxwell Pond. Few people still fish here, but with limited success. Neighborhood children use the steep hillside adjacent to the pond for sledding in the winter, but the numerous historic uses of Maxwell Pond are greatly diminished. The shoreline is much the same as it was a century ago, but characteristics of the pond itself have changed immensely. The obstacles facing the pond are relatively few, so restoration of the pond's historic uses is certainly possible in the near future.

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The History of Nutts Pond

Nutts Pond has played an important part in Manchester history since the city's earliest days. It has been the location of summer fun and winter commerce over the years but today serves only as a testament to what urban encroachment does to an aquatic ecosystem. This pond is one of Manchester's few natural ponds never having been dammed. The remains of a weir are located in the outlet, Tannery Brook, but the pond's physical characteristics are relatively unchanged from its original state.

Since colonial times Nutts Pond has been known by more than one name. In the mid-1800's, it was known as Fort Pond, but "in ancient time(s) was known as Swager's Pond" (Potter, 1856). It came to be known as Nutts Pond shortly thereafter, named for a popular local circus performer, Commodore Nutt. At that time, the Nutt family farm was situated near the pond.

Commodore Nutt was the son of a New Hampshire farmer. He stood twenty-nine inches tall and weighed twenty-four pounds. Like his rival, Tom Thumb, he was discovered by P.T. Barnum, and in fact because of the resemblance between the two, many people suspected that Nutt was in fact Thumb posing under a different name. To exploit the situation, Barnum began to exhibit the two together, billing them as "The Two Smallest Men and Greatest Curiosities Living."

Historical Uses

The pond has been put to many uses over the years. Archeological evidence discovered in 1976 substantiates historical records of the existence of a fort on the north shore of the pond (Slown, 1987). In 1746, Archibald Stark, seeing a necessity for a safe haven for colonists from Native American attacks, built a wooden garrison at this site (Manchester Leader, 1929).

The well still exists at the site today although it has long since been filled in. The Manchester Coal and Ice Company, which owned the lot in 1928, deeded the well to the Molly Stark Chapter of the Daughters of the American Revolution (DAR) on December 24, 1928.

The Manchester Coal & Ice Company harvested ice at Nutts Pond until at least the 1920's, but preceeding them were at least two other ice companies. Ice harvesting at Nutts Pond probably began about 1860 by A.L. Walker, followed by Dickey & Young, and then L.B. Bodwell & Company (The Mirror, 1899). Nutts Pond ice was described by The Mirror in 1899, as "pure, sweet and clear."

By 1938, Nutts Pond had become a popular swimming and recreation area. A 1938 NH Fish and Game Department survey indicates that the pond was routinly treated with chlorine due to the high volume of bathers, thus preventing any fisheries management plan on the part of the Fish and Game Department. In 1951, the area now known as Precourt Park, on the pond's north side, was sold to the city by the Manchester Coal & Ice Company.

During the 1950's and '60's, Nutts Pond gained popularity as a swimming area and as result the Parks and Recreation Department installed a large scale chlorination system to treat high bacteria levels (Slown, 1987). However, water testing after chlorination revealed that high bacteria levels still prevailed and the pond was closed to public swimming in July, 1968. It was later ascertained that the bacterial pollution was the result of a combined sewer outfall that emptied into the pond at a point near the swimming area. Though new sewer systems were installed in the area to accommodate large scale commercial and multi-family housing

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The History of Pine Island Pond

Among Manchester's urban ponds, Pine Island Pond may be historically, the most famous due to its hosting of a popular amusement park. Like so many other Manchester ponds, Pine Island Pond is an artificial impoundment created by a dam at its outlet. This has created a natural jewel in Manchester's quickly growing South end. Several homes and cottages occupy the pond's northwestern shore, and it is bordered on its eastern side by

Over the years, Pine Island Pond has been heavily used for recreational as well as educational purposes. In 1902, Manchester Traction, Light & Power Company opened Pine Island Park – an amusement park with rides, games, a roller rink and dance hall. A swimming area was also featured at the pond. In its heyday, the park would attract fun-seeking patrons from as far away as Boston. Easy access to the park was provided by a trolley car line owned by Manchester Traction, Light & Power. Through its duration, the park endured hurricanes and fires, but was ultimately unable to keep up with progress (Clayton, 1993). After struggling for decades, the park closed in 1962.

In recent times Pine Island Pond has been the subject of some contention. It was completely drained at one point to the dismay of neighborhood residents and proposed for filling and development at one time as well. The current Pine Island Park, a playground and passive recreation area, was once the site of 4-H educational center until it was lost to a fire. It now consists of interpretive nature trials that meander along part of the shoreline, created as an Eagle Scout project. A new playground was also recently constructed at the site.

Pond side residents have always been concerned when it comes to the future of Pine Island Pond. It is widely agreed among long-time Pine Island Pond neighbors that the pond seems to be filling in with sediment rather quickly.

It is still a fairly popular and productive fishing spot, but as the pond continues to become shallower, this situation is sure to change. Historic uses of the pond have not been altered greatly over the years, however, pond-front property owners are reluctant to swim there these days. Urban runoff has yet to make an irreversible difference at Pine Island Pond, although the effects are certainly becoming apparent.

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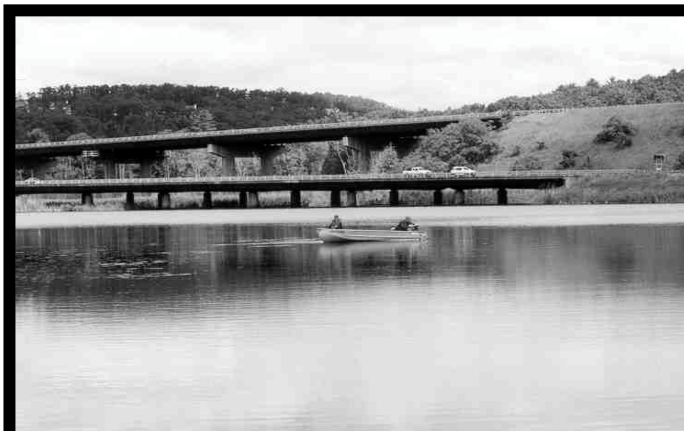
The History of Stevens Pond

Stevens Pond has been a popular recreation spot with Manchester's citizens young and old for generations. The pond is still heavily used by area residents for fishing and skating. This natural pond covers approximately 16 acres with a large wetland area on the northwest side of the pond. This provides excellent habitat for wetland species such as red-winged blackbirds and great blue herons.

Historical Uses



Fisherman on Stevens Pond – Summer 2001

According to N.H. Fish and Game Department records, Stevens Pond was experimentally reclaimed for smallmouth bass in 1952. This involved the application of emulsified rotenone (a fish toxin) to the pond surface, in hopes of killing all fish in the pond. Although a complete kill was not achieved due to the presence of a floating bog along part of the shoreline preventing adequate spraying, over 9,000 smallmouth bass fingerlings and 45,000 smallmouth bass fry were stocked over the course of 1952 and 1953 (NH Fish & Game, 1960). Despite this effort, the dominant fish species in the pond remained brown bullheads and common suckers, as was discovered through fish sampling in 1958. Two species of crayfish were also stocked at Stevens Pond in 1953. After six years, one of the crayfish species had established itself and maintained a substantial population (NH Fish & Game, 1960). The pond was described as "highly productive", with "good populations of desirable game fish" which were in "excellent condition."

In 1964, Interstate 93 was completed through Manchester. The southbound lanes were built directly over the northeastern edge of Stevens Pond. Since that time, water quality in Stevens Pond has deteriorated. "Analyses from 1981 to 1997 show…a 100% increase in conductivity levels, a 220% increase in sodium levels, and a 182 % increase in chloride levels." Clearly, Interstate 93 runoff has had an effect on the pond over the years.

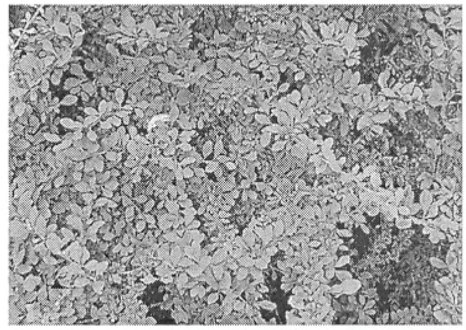
The Pond Today

Stevens Pond's value as a natural resource was noted in a letter from Arthur E. Newell, Supervisor of Fisheries Management and Research for the N.H. Department of Fish & Game, to James Hall of Manchester dated 11/23/1960. Mr. Newell states: "…biologists in the Fish and Game Department are interested in preserving certain strategically located ponds, such as Stevens Pond, in their original state." Unfortunately, Stevens Pond has not been preserved, but abused over the years. Nevertheless, it persists as a focal point for birdwatchers, fishermen, and ice skaters of Manchester's East Side.

Common Exotic Plants Of Crystal Lake

Bush Honeysuckle - Tartarian spp.
(Lonicera tartarica)

Bush honeysuckles can live in a broad range of communities with varying moisture and shade levels. Most natural communities are susceptible to invasion by one or more of the species, with or without previous invasions. Woodlands are most affected, and are particularly vulnerable if the habitat is already disturbed. Bush honeysuckles thrive in sunny, upland habitats, including forest edges, roadsides, pastures, and abandoned fields. Bush honeysuckles are native to Asia and western Europe. Tartarian honeysuckle was introduced to North America as an ornamental in 1752. The others were introduced in the late 1800's. Distribution is typically near large urban areas, but rural infestations have occurred where the species were introduced to provide wildlife with cover and a food source. The distribution of bush honeysuckle is aided by birds, which consume the ripened fruit in summer and disperse the seeds over long distances. Their vigorous growth inhibits development of native shrub and ground layer species; eventually they may entirely replace native species by shading and depleting soil moisture and nutrients.

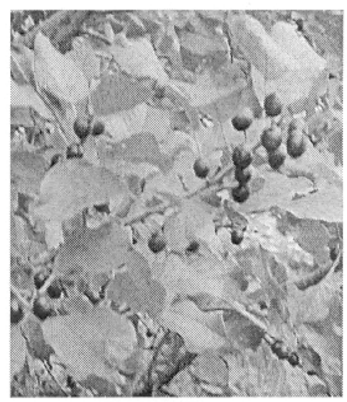


Japanese Barberry *(Berberis thunbergii)*

Imported from Japan in 1864, seeds were later sent to the Arnold Arboretum (Boston) in about 1875. Since then this species has been a very popular ornamental in yards, as hedges, and along highways because of its scarlet fruit, attractive fall color, and ease of cultivation. The seeds dispersed by birds have spread it from cultivated gardens and yards to pastures, woodlands, ledges, and floodplains where it grows equally well in sun or shade. In young forests, barberry forms thorny thickets that shade out and limit the growth of native plants. A deciduous shrub growing to 6 feet with arching branches of dense foliage composed of small rounded leaves atop short individual spines. The yellow flowers produce bright red oblong berries that develop in late summer and persist into winter. The inner bark and roots are yellow. As one of the first plants to leaf out in the spring, it is often recognizable as a pale green haze over the forest floor in early spring.

Glossy Buckthorn (*Rhamnus frangula*)

Glossy buckthorn is a shrub or small tree that produces small dark fruits. These fruits occur singly or in small groups in leaf axils and contains a poisonous substance that probably deters many potential consumers, however, European Starlings can apparently eat the fruit with impunity and they have been suggested as the primary agent responsible for the spread of glossy buckthorn. Glossy buckthorn occurs in a range of wetland communities including fens, marshes, and bogs. Although the plant has a preference for wetlands, it also occurs in some upland habitats, such as forests, fencerows, wood edges, prairies, and old fields. When glossy buckthorn invades a natural area it displaces the native species by the dense shade produced by the stand.



Common Reed (*Phragmites communis*)

Common reed has erect stems that grow up to 15 feet high and end in dense floral heads. These floral heads are purplish when young, and white or light brown and feathery when mature. Common reed's sharp, long, pointed green leaves grow up to 2 feet long and 2 inches wide. It flowers from late July through October. Stands of common reed disperse seeds, or pieces of underground stems, called rhizomes. Once established, stands grow predominately by sending up new shoots each spring from existing rhizomes, or from runners, called stolons. If an aerial shoot is knocked over, it can act like a rhizome, taking root and producing new shoots. This grass can return year after year, and some stands are believed to be 1,000 years old. Common reed grows in sunny, wetland habitats. It is found in fresh and alkaline marshes, pond margins, swamps, and ditches. Not only does it thrive in freshwater habitats but it can tolerate brackish waters as well. It is prevalent in wet areas that have disturbed or polluted soils. Human activities such as road

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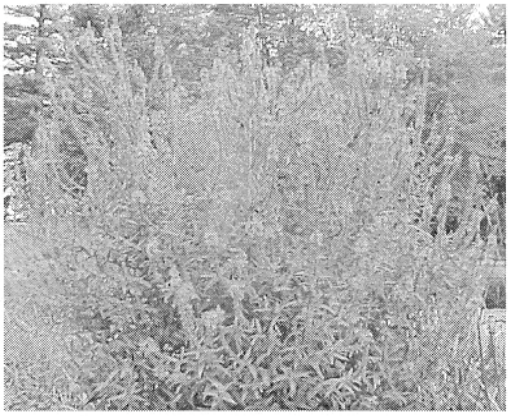
Jen Drociak, Manchester Conservation Commission 2002

Common Exotic Plants Of Dorrs Pond

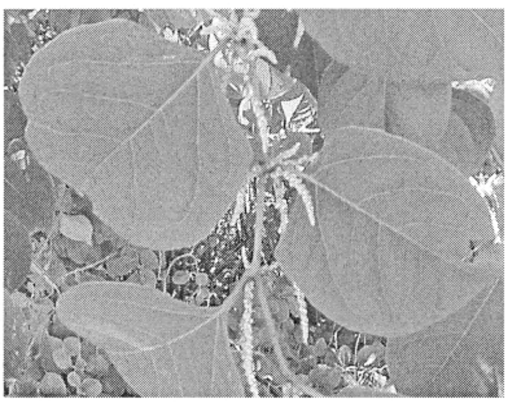


Purple Loosestrife (*Lythrum salicaria*)

Perennial herb with a square, woody stem and opposite o whorled leaves. Purple loosestrife flowers from Jul through August and is named for its bright purple flowe that spikes from the top of the plant. One plant may grov as an individual stalk or as several stalks clumped togethe Purple loosestrife is native to Eurasia. It was originall introduced to eastern North America in the early to mi 1800's. This invasive plant was probably accidentall introduced via ship ballast or brought over for use as a ornamental plant. Optimum habitats include freshwate marshes, open stream margins, and alluvial floodplains. Purple loosestrife also occurs in wet meadows, river banks and edges of ponds and reservoirs. It favors fluctuatin water levels and other conditions often associated wit disturbed sites, such as construction sites for docks o marinas. Purple loosestrife is often associated with cattail reed canary grass, and other moist soil plants.

Glossy Buckthorn (*Rhamnus frangula*)

Glossy buckthorn is a shrub or small tree that produces small dark fruits. These fruits occur singly or in small groups in leaf axils and contains a poisonous substance that probably deters many potential consumers, however, European Starlings can apparently eat the fruit with impunity and they have been suggested as the primary agent responsible for the spread of glossy buckthorn. Glossy buckthorn occurs in a range of wetland communities including fens, marshes, and bogs. Although the plant has a preference for wetlands, it also occurs in some upland habitats, such as forests, fencerows, wood edges, prairies, and old fields. When glossy buckthorn invades a natural area it displaces the native species by the dense shade produced by the stand.



Japanese Knotweed (*Polygonum cuspidatum*)

Japanese knotweed is a native of Japan and was probably introduced to the U.S. in the 1800's as an ornamental. Initially useful for erosion control, as an ornamental. Japanese knotweed spreads rapidly from stout long rhizomes. Seeds are distributed by water in floodplains, transported with fill dirt, and to a lesser extent are wind-blown. Populations escaped from neglected gardens, and discarded cuttings are common urban paths of distribution. Japanese knotweed can tolerate a variety of adverse conditions including full shade, high temperatures, high salinity, and drought. It is found near water sources, in low-lying areas, waste places, utility rights of way, and around old homesites. It can quickly become an invasive pest in natural areas after escaping from cultivated gardens. It poses a significant threat to riparian areas, where it can survive severe floods.

Oriental Bittersweet (*Celastrus orbiculata*)

Oriental bittersweet is a deciduous twining vine with alternate, round, glossy leaves. Small greenish flowers occur in clusters next to the leaf stems. The leathery capsule surrounding the seed ripens to a bright orange. This species grows in alluvial woods, roadsides, thickets, and old homesites. Oriental bittersweet, a native of Asia, was brought to the United States for cultivation during the middle of the nineteenth century. This plant can overrun natural vegetation by overtopping all other species and forming thick nearly pure stands. It can strangle shrubs and tree limbs, and weaken a tree by girdling the trunk and weighting the crown making the tree more susceptible to wind and ice damage. bittersweet, thus threatening genetic integrity of the native species.

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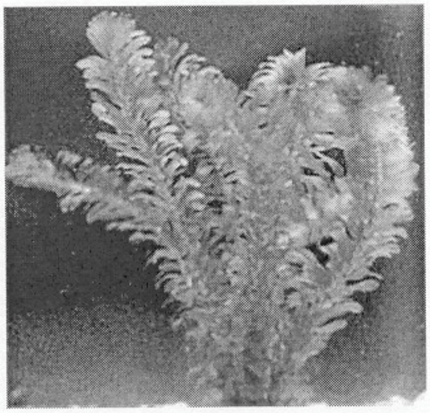
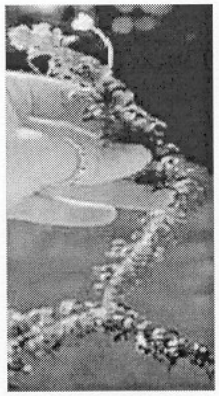
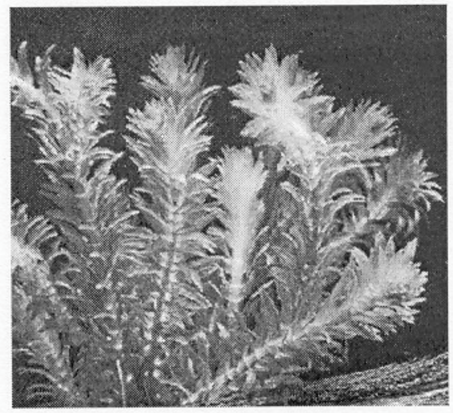
Jen Drociak, Manchester Conservation Commission 2002

Common Exotic Plants Of Nutts Pond







Brazillian Elodea/Waterweed (*Egaria densa*)

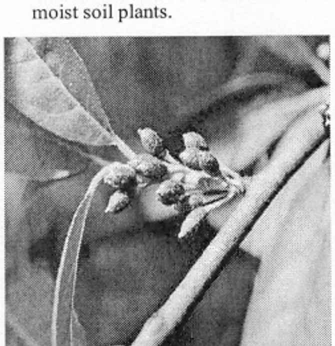
This native of South America can sometimes be found in pet stores, which sell them for use in home aquaria. The plant is free-floating with three to five light-green leaves in whorls. This species is easily confused with the exotic Hydrilla (not yet documented in New Hampshire) and the native Waterweed (*Elodea canadensis*). Leaves are finely-toothed along the margins. Brazillian elodea forms whitish flowers that float at the surface of the water. This plant reproduces by fragmentation. Fortunately, this is the only waterbody in New Hampshire which Brazillian elodea has been documented. If you boat on this pond, please be sure to clean your outboard engine, and trailer to keep fragments out of any other waterbody!

Purple Loosestrife (*Lythrum salicaria*)

Perennial herb with a square, woody stem and opposite or whorled leaves. Purple loosestrife flowers from July through August and is named for it bright purple flower that spikes from the top of the plant. One plant ma grow as an individual stalk or as several stalks clumped together. Purpl loosestrife is native to Eurasia. It was originally introduced to easter North America in the early to mid 1800's. This invasive plant wa probably accidentally introduced via ship ballast or brought over for use a an ornamental plant. Optimum habitats include freshwater marshes, ope stream margins, and alluvial floodplains. Purple loosestrife also occurs i wet meadows, river banks, and edges of ponds and reservoirs. It favor fluctuating water levels and other conditions often associated wit disturbed sites, such as construction sites for docks or marinas. Purpl loosestrife is often associated with cattail, reed canary grass, and othe moist soil plants.

Glossy Buckthorn (*Rhamnus frangula*)

Glossy buckthorn is a shrub or small tree that produces small dark fruits. These fruits occur singly or in small groups in leaf axils and contains a poisonous substance that probably deters many potential consumers, however, European Starlings can apparently eat the fruit with impunity and they have been suggested as the primary agent responsible for the spread of glossy buckthorn. Glossy buckthorn occurs in a range of wetland communities including fens, marshes, and bogs. Although the plant has a preference for wetlands, it also occurs in some upland habitats, such as forests, fencerows, wood edges, prairies, and old fields. When glossy buckthorn invades a natural area it displaces the native species by the dense shade produced by the stand.



Autumn Olive (*Eleagnus umbellata*)

Autumn olive is a medium to large shrub (up to 20 feet tall). The leaves are oval in shape, and lack teeth. The upper surface of leaves is dark green to grayish-green, while the lower surface is covered with silvery white scales, that can be seen from a distance. The small light yellow flowers bloom in late April and May. Flowers and fruits, when present, are borne along twigs. The small fleshy fruits range in color from pink to red and are produced in abundance each year. Autumn olive was introduced into U.S. cultivation in 1830 from its native range in China, Japan, and Korea. It has been used as screens and barriers along highways, to stabilize and revegetate road banks, and to reclaim mine spoil. Autumn olive occurs in disturbed areas, fields, pastures, and roadsides, where it has been widely planted. It has also been noted from prairies, open woodlands, and forest edges.

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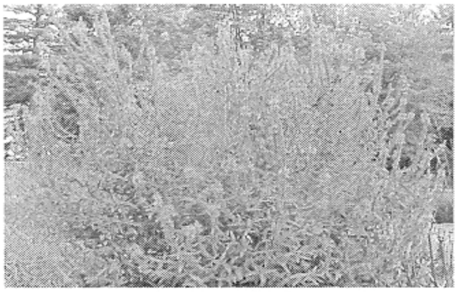
Common Exotic Plants Of Pine Island Pond



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Black Locust *(Robina pseudoacacia)*

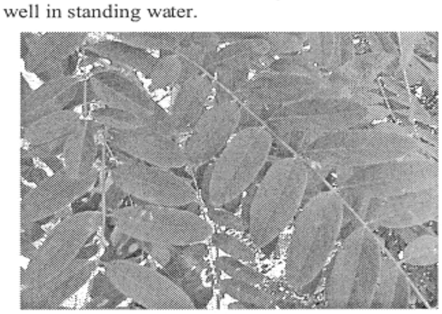
Black locust is native to Southern Appalachia and the Ozarks. It was introduced in the early 1900's because its aggressive growth pattern and extensive root system discourages soil erosion. Black locust wood is also valued for its durability and high fuel value, and flowers provide good forage for bees. The plant typically reproduces by root suckering and stump sprouting. Root suckers arise spontaneously from established root systems, sprouting new shoots and interconnecting fibrous roots to form extensive, dense groves of clones. Black locust is susceptible to severe insect damage from locust borers, locust leaf miners, and locust twig borers. Black locust commonly occurs in disturbed habitats like pastures, degraded woods, thickets, old fields, and roadsides. Successful reproduction by roots has contributed to the spread of black locust in upland forests, prairies, and savannas. Because dense clonal stands shade out most understory vegetation, such tree groves can be detrimental to native vegetation.

Climbing Bittersweet (*Celastrus orbiculata*)

Climbing bittersweet is a deciduous twining vine with alternate, round, glossy leaves. Small greenish flowers occur in clusters next to the leaf stems. The leathery capsule surrounding the seed ripens to a bright orange. This species grows in alluvial woods, roadsides, thickets, and old homesites. Climbing bittersweet, a native of Asia, was brought to the United States for cultivation during the middle of the nineteenth century. This plant can overrun natural vegetation by overtopping all other species and forming thick nearly pure stands. It can strangle shrubs and tree limbs, and weaken a tree by girdling the trunk and weighting the crown making the tree more susceptible to wind and ice damage thus threatening the integrity of the native species.

Multiflora Rose *(Rosa multiflora)*

Clusters of many white flowers appear on this thorny shrub during May or June. The flowers develop into small, hard rose hips that remain on the plant throughout winter. The majority of plants develop from seeds remaining in the soil close to the plants from which they were produced. Birds and mammals consume the hips and can disperse them greater distances. Rose seeds may remain viable in the soil for10-20 years. Multiflora rose was introduced from Japan in 1886 as rootstock for cultivated roses. In the 1930's it was advocated for use in soil erosion control. In the late 1960's, many state conservation departments were distributing rooted cuttings to landowners to be planted for living fences and soil conservation. Managers recognized that plantings provided excellent escape cover and a source of winter food for wildlife. The species soon spread and became a serious invader of agricultural lands, pastures, and natural communities from the Midwest to the East Coast. Multiflora rose occurs in fields, pastures, and roadsides. It also may occur in dense forests, particularly near natural disturbances such as treefall gaps and along streambanks. It has a wide tolerance for soil, moisture, and light conditions; but it does not grow well in standing water.



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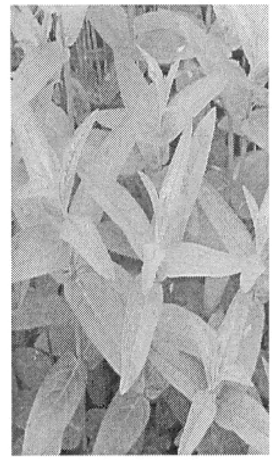
Jen Drociak, Manchester Conservation Commission 2002

Common Exotic Plants Of Stevens Pond

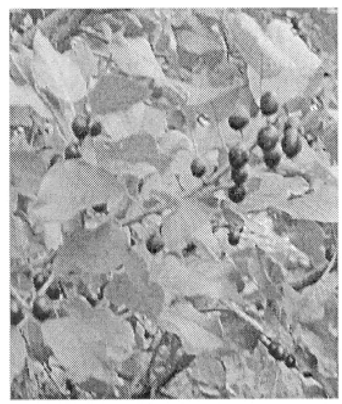
Purple Loosestrife (*Lythrum salicaria*)

Perennial herb with a square, woody stem and opposite o whorled leaves. Purple loosestrife flowers from Jul through August and is named for its bright purple flower tha spikes from the top of the plant. One plant may grow as a individual stalk or as several stalks clumped together. Purpl loosestrife is native to Eurasia. It was originally introduce to eastern North America in the early to mid 1800's. Thi invasive plant was probably accidentally introduced via shi ballast or brought over for use as an ornamental plan Optimum habitats include freshwater marshes, open strea margins, and alluvial floodplains. Purple loosestrife als occurs in wet meadows, river banks, and edges of ponds an reservoirs. It favors fluctuating water levels and othe conditions often associated with disturbed sites, such a construction sites for docks or marinas. Purple loosestrife i often associated with cattail, reed canary grass, and othe moist soil plants.



Glossy Buckthorn (*Rhamnus frangula*)

Glossy buckthom is a shrub or small tree that produces small dark fruits. These fruits occur singly or in small groups in leaf axils and contains a poisonous substance that probably deters many potential consumers, however, European Starlings can apparently eat the fruit with impunity and they have been suggested as the primary agent responsible for the spread of glossy buckthorn. Glossy buckthom occurs in a range of wetland communities including fens, marshes, and bogs. Although the plant has a preference for wetlands, it also occurs in some upland habitats, such as forests, fencerows, wood edges, prairies, and old fields. When glossy buckthorn invades a natural area it displaces the native species by the dense shade produced by the stand.



Common Reed (*Phragmites communis*)

Common reed has erect stems that grow up to 15 feet high and end in dense floral heads. These floral heads are purplish when young, and white or light brown and feathery when mature. Common reed's sharp, long, pointed green leaves grow up to 2 feet long and 2 inches wide. It flowers from late July through October. Stands of common reed disperse seeds, or pieces of underground stems, called rhizomes. Once established, stands grow predominately by sending up new shoots each spring from existing rhizomes, or from runners, called stolons. If an aerial shoot is knocked over, it can act like a rhizome, taking root and producing new shoots. This grass can return year after year, and some stands are believed to be 1,000 years old. Common reed grows in sunny, wetland habitats. It is found in fresh and alkaline marshes, pond margins, swamps, and ditches. Not only does it thrive in freshwater habitats but it can tolerate brackish waters as well. It is prevalent in wet areas that have disturbed or polluted soils. Human activities such as road and housing development have made the invasion of common reed quite successful in adjacent wetland areas.

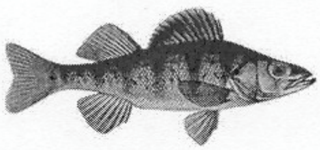
Manchester Urban Ponds Restoration Program One City Hall Plaza - Manchester NH 03101 (603) 624-6450

Jen Drociak, Manchester Conservation Commission 2002

Common Fish Species Of Crystal Lake

Sampled on May 30 & August 22 2001

Species	# Sampled	Avg. Length (mm)	Avg. Wt. (g)
Yellow Perch	83	106	17
Pumpkinseed	32	106	44
Largemouth Bass	17	308	481
Bluegill	4	191	175
E. Chain Pickerel	4	290	148

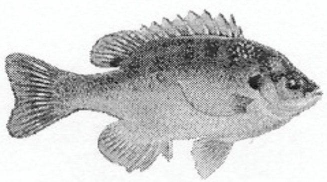


Yellow Perch (*Perca flavescens*)

The yellow perch is easily recognized by its golden-yellow colored body crossed by six to eight broad dark vertical bands. They occur in warmwater, but not where there is a strong current. Yellow perch are schooling fish and can be found in shallow, weedy water. These fish feed mainly on small aquatic insects, crustaceans, and small fishes.

Largemouth Bass (*Micropterus salmoides*)

The largemouth bass closely resembles the smallmouth bass, but the jaw of the largemouth extends well beyond the eye. The largemouth bass also exhibits a horozontal dark band or stripe along its side. The largemouth bass thrives best in warm, shallow, mud-bottomed lakes, ponds or streams where there are plenty of weeds. It is a solitary fish. Most of its time is spent lurking among aquatic vegetation, beneath an overhanging brank or under a brush-covered bank, waiting for prey to swim by. It's diet consists of frogs and bait fish, though snakes, mice, snails, and worms can also become a meal.

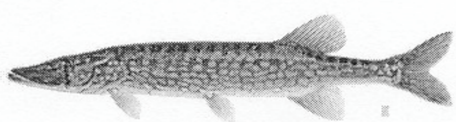


Bluegill (*Lepomis macrochirus*)

The bluegill's distinguishing characteristics are the conspicuous dark blotches at the back of the soft-rayed portion of the dorsal fin; the large, square-shaped, blue-black flap behind the eye; and the slate-blue lower jaw and cheek. Not a New Hampshire native, the bluegill, sometimes called "Kibee" has extended its range in the state. The bluegill is at home in quiet, warm, weedy waters similar to those inhabited by other sunfish, such as the pumpkinseed.

Pumpkinseed (*Lepomis gibbosus*)

The pumpkinseed can be distinguished from the bluegill by the bright orange spot at the tip of the ear flap and lack of dark spot on the soft portion of the dorsal fin. Breeding males are especially colorful with iridescent blue radiating lines on their cheeks and gill covers. The preferred habitat of the pumpkinseed is slow-moving water and protected coves with a mucky or sandy substrate and beds of submerged aquatic vegetation. The preferred food is aquatic insects, snails, small fish, and fish eggs.



Eastern Chain Pickerel (*Esox niger*)

The chain pickerel has a slender, elongated body, large mouth with formidable teeth, and dorsal and anal fins placed far back near the tail. A characteristic pattern of dark, chain-like markings on the side distinguishes it from other members of the pike family. Any quiet, shallow water with a mud bottom, an abundance of aquatic vegetation and food fishes is ideal habitat for the chain pickerel. These fish like to hide in weeds waiting for a meal to swim by. The chain pickerel is a voracious carnivore. Its diet includes golden shiners, brown bullheads, yellow perch, and sunfish.

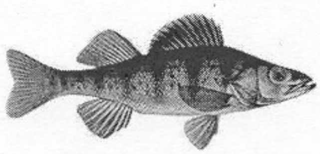
Manchester Urban Ponds Restoration Program One City Hall Plaza – Manchester NH 03101 (603) 624-6450

Jen Drociak, Manchester Conservation Commission 2002

Common Fish Species Of Dorrs Pond

Sampled on September 24, 2001

Species	# Sampled	Avg. Length (mm)	Avg. Wt. (g)
Common White Sucker	86	109	93
Yellow Perch	40	175	160
Largemouth Bass	30	250	352
E. Chain Pickerel	21	277	160
Bluegill	20	178	135
Golden Shiner	8	210	190

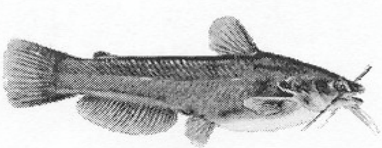


Yellow Perch (*Perca flavescens*)

The yellow perch is easily recognized by its golden-yellow colored body crossed by six to eight broad dark vertical bands. They occur in warmwater, but not where there is a strong current. Yellow perch are schooling fish and can be found in shallow, weedy water. These fish feed mainly on small aquatic insects, crustaceans, and small fishes.

Bluegill (*Lepomis macrochirus*)

The bluegill's distinguishing characteristics are the conspicuous dark blotches at the back of the soft-rayed portion of the dorsal fin; the large, square-shaped, blue-black flap behind the eye; and the slate-blue lower jaw and cheek. Not a New Hampshire native, the bluegill, sometimes called "Kibee" has extended its range in the state. The bluegill is at home in quiet, warm, weedy waters similar to those inhabited by other sunfish, such as the pumpkinseed.



Yellow Bullhead (*Ameiurus natalis*)

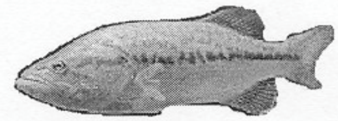
The yellow bullhead is typically light yellow to olive green on the back and is often somewhat mottled. The belly is yellowish to white. The tail is not notched and may be slightly rounded. The yellow bullhead is omnivorous, feeding on a variety of plant and animal material, both live and dead. Immature aquatic insects and crustaceans often comprise its diet.

Golden Shiner (*Notemigonus crysoleucas*)

The young golden shiner is silvery with a dusky band along the side. This band fades with age as the fish takes on a golden color. Golden shiners live in clear, weedy, quiet shallow lakes, ponds, and occasionally rivers. Both the young and adult fish show schooling behavior. Golden shiners feed on planktonic crustaceans, aquatic insects, and algae.

Common White Sucker (*Catastomus commersoni*)

Is dark greenish, grey, coppery brown and is black on its back. Its sides have a brassy/silvery luster and its lower sides are creamy white. This fish is primarily a bottom feeder with aquatic insect larvae, small mollusks, crustaceans, and various worms. With its fleshy mouth aimed downward, they vacuum up worms, clams, and, some say, the eggs of other fish. They are prey species to the Northern Pike, Largemouth Bass, and Smallmouth Bass.



Largemouth Bass
(*Micropterus salmoides*)

The largemouth bass closely resembles the smallmouth bass, but the jaw of the largemouth extends well beyond the eye. The largemouth bass also exhibits a horozontal dark band or stripe along its side. The largemouth bass thrives best in warm, shallow, mud-bottomed lakes, ponds or streams where there are plenty of weeds. It is a solitary fish. Most of its time is spent lurking among aquatic vegetation, beneath an overhanging brank or under a brush-covered bank, waiting for prey to swim by. It's diet consists of frogs and bait fish, though snakes, mice, snails, and worms can also become a meal.

Pumpkinseed (*Lepomis gibbosus*)

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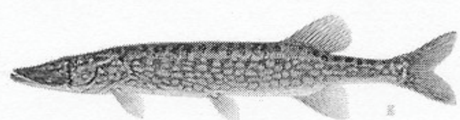

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Jen Drociak, Manchester Conservation Commission 2002

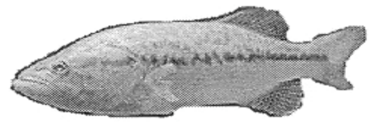
Common Fish Species Of Nutts Pond

Sampled on August 8, 2001

Species	# Sampled	Avg. Length (mm)	Avg. Wt. (g)
Pumpkinseed	70	98	30
Largemouth Bass	57	201	180
Yellow Perch	14	139	52
Bluegill	13	153	95
Golden Shiner	4	115	14
E. Chain Pickerel	2	370	269

Yellow Perch (*Perca flavescens*)

The yellow perch is easily recognized by its golden-yellow colored body crossed by six to eight broad dark vertical bands. They occur in warmwater, but not where there is a strong current. Yellow perch are schooling fish and can be found in shallow, weedy water. These fish feed mainly on small aquatic insects, crustaceans, and small fishes.



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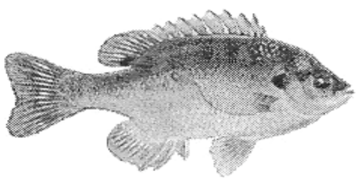

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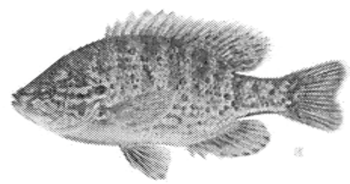
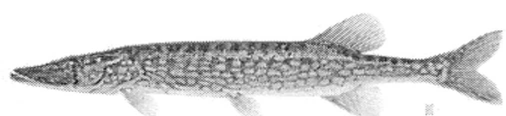


Pumpkinseed (*Lepomis gibbosus*)

The pumpkinseed can be distinguished from the bluegill by the bright orange spot at the tip of the ear flap and lack of dark spot on the soft portion of the dorsal fin. Breeding males are especially colorful with iridescent blue radiating lines on their cheeks and gill covers. The preferred habitat of the pumpkinseed is slow-moving water and protected coves with a mucky or sandy substrate and beds of submerged aquatic vegetation. The preferred food is aquatic insects, snails, small fish, and fish eggs.

Golden Shiner (*Notemigonus crysoleucas*)

The young golden shiner is silvery with a dusky band along the side. This band fades with age as the fish takes on a golden color. Golden shiners live in clear, weedy, quiet shallow lakes, ponds, and occasionally rivers. Both the young and adult fish show schooling behavior. Golden shiners feed on planktonic crustaceans, aquatic insects, and algae.



Eastern Chain Pickerel (*Esox niger*)

The chain pickerel has a slender, elongated body, large mouth with formidable teeth, and dorsal and anal fins placed far back near the tail. A characteristic pattern of dark, chain-like markings on the side distinguishes it from other members of the pike family. Any quiet, shallow water with a mud bottom, an abundance of aquatic vegetation and food fishes is ideal habitat for the chain pickerel. These fish like to hide in weeds waiting for a meal to swim by. The chain pickerel is a voracious carnivore. Its diet includes golden shiners, brown bullheads, yellow perch, and sunfish.

Manchester Urban Ponds Restoration Program One City Hall Plaza - Manchester NH 03101 (603) 624-6450

Jen Drociak, Manchester Conservation Commission 2002

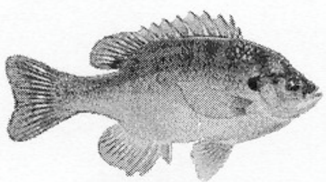
Common Fish Species Of Stevens Pond

Sampled on July 11, 2000

Species	# Sampled	Avg. Length (mm)	Avg. Wt. (g)
Bluegill	67	110	41
Largemouth Bass	43	243	244
Pumpkinseed	20	130	55
Yellow Perch	14	237	179
E. Chain Pickerel	7	287	138
Common White Sucker	2	400	714

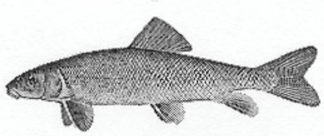
Yellow Perch (*Perca flavescens*)

The yellow perch is easily recognized by its golden-yellow colored body crossed by six to eight broad dark vertical bands. They occur in warmwater, but not where there is a strong current. Yellow perch are schooling fish and can be found in shallow, weedy water. These fish feed mainly on small aquatic insects, crustaceans, and small fishes.



Bluegill (*Lepomis macrochirus*)

The bluegill's distinguishing characteristics are the conspicuous dark blotches at the back of the soft-rayed portion of the dorsal fin; the large, square-shaped, blue-black flap behind the eye; and the slate-blue lower jaw and cheek. Not a New Hampshire native, the bluegill, sometimes called "Kibee" has extended its range in the state. The bluegill is at home in quiet, warm, weedy waters similar to those inhabited by other sunfish, such as the pumpkinseed.

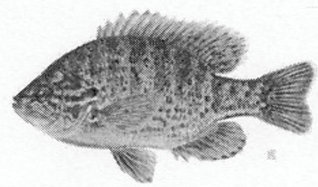


Common White Sucker (*Catastomus commersoni*)

Is dark greenish, grey, coppery brown and is black on its back. Its sides have a brassy/silvery luster and its lower sides are creamy white. This fish is primarily a bottom feeder with aquatic insect larvae, small mollusks, crustaceans, and various worms. With its fleshy mouth aimed downward, they vacuum up worms, clams, and, some say, the eggs of other fish. They are prey species to the Northern Pike, Largemouth Bass, and Smallmouth Bass.

Largemouth Bass (*Micropterus salmoides*)

The largemouth bass closely resembles the smallmouth bass, but the jaw of the largemouth extends well beyond the eye. The largemouth bass also exhibits a horozontal dark band or stripe along its side. The largemouth bass thrives best in warm, shallow, mud-bottomed lakes, ponds or streams where there are plenty of weeds. It is a solitary fish. Most of its time is spent lurking among aquatic vegetation, beneath an overhanging brank or under a brush-covered bank, waiting for prey to swim by. It's diet consists of frogs and bait fish, though snakes, mice, snails, and worms can also become a meal.



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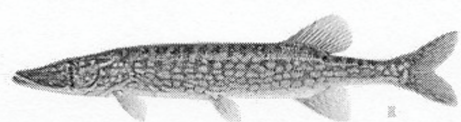

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Manchester Urban Ponds Restoration Program One City Hall Plaza - Manchester NH 03101 (603) 624-6450

Jen Drociak, Manchester Conservation Commission 2002

Manchester Urban Ponds Restoration Program
Pollution Prevention On-Site Assessment Survey

Name of Business: ______________________________ Contact: ______________________________

Assessed By: ____________________________ Date: ____

Section 1: General Information

1. What type of business is this? ____
2. Are you aware this facility is in the Nutts Pond watershed? Y N
3. Does this facility have an aboveground storage tank? Y N
4. Does this facility have an underground storage tank? Y N
5. Is there noticeable trash/litter around the property? Y N

Section 2: Solid Waste/Dumpster Maintenance

1. Is there a dumpster on site? Y N
2. What types of waste are disposed of in the dumpster? ____
3. What is the distance of dumpster to the nearest swale, catch basin, or stream? _____________________
4. Is the dumpster overflowing? Y N
5. How often is the dumpster emptied? ____
6. Is the dumpster lid kept closed? Y N
7. Is there a better location for the dumpster? Y N
   If so, where? ____
8. Does this facility recycle? Y N
9. If so, how often are the recyclables picked-up or dropped-off at a transfer station?
   ____
10. Does this facility safely store mercury-containing fluorescent bulbs? Y N
11. Does this facility recycle mercury-containing fluorescent bulbs? Y N

Section 3: Floor Drains

1. Are there floor drains at this facility? Y N
2. Are the floor drains sealed? Y N
3. Are the floor drains connected to a registered holding tank? Y N
4. Are the floor drains connected to a municipal sewer system? Y N
5. What is discharged to the drains? ____

Section 4: Stormwater Management

1. Does the site have adequate drainage? Y N
2. What type of drainage device does your facility have? (Catch basins, Culverts, Swales, Stormwater Treatment Devices) ____
3. If this facility has catch basins, how often are they cleaned? ____________________________________
4. Do the storm drains overflow during rainstorms? Y N
5. Does this facility minimize the amount of impervious (paved) areas outside? Y N
6. Does this facility maintain buffer strips between surface waters and upland areas? Y N
7. Are there lawns on site? Y N
8. If so, are the lawns fertilized? Y N
9. Does this facility soil test before fertilizing? Y N
10. Are pesticides/insecticides used anywhere on the property? Y N
11. How often is the parking lot swept? ____

Section 5: Outdoor Storage of Products or Hazardous Wastes

1. Are Products or Hazardous Wastes are stored outdoors? Products Wastes N/A
2. If so, what types of materials are being stored? ______________________________
3. Are these materials being stored on an impermeable surface? Y N
4. Are these materials protected from the elements? Y N
5. Is there any noticeable leakage from the containers? Y N

Section 4: Cleaning Products

1. What type of cleaning products does this facility utilize? ______________________________

Section 5: Used Oil (For Automotive Facilities Only)

Does this facility:
1. Store used oil in structurally sound containers? Y N
2. Recycle Used Oil? Y N
3. Keep containers closed and sealed except when oil is being added or removed from the container or tank? Y N
4. Have a used oil burner? Y N
5. Properly drain and dispose of used oil filters? Y N
6. Recycle used oil filters with a scrap metal dealer? Y N
7. Own a filter crusher? Y N

Section 6: Parts Washing & Absorbents (For Automotive Facilities Only)

1. Does this facility use absorbents that are wringable and reusable? Y N
2. Does this facility use a laundering service? Y N
3. Does this facility have a parts washer? Y N
4. How often does this facility change the solvent? ______________________________
6. How often does the solvent get disposed of? ______________________________
7. How does this facility dispose of soiled rags? ______________________________

Section 7: Lead-Acid Batteries & Antifreeze (For Automotive Facilities Only)

Does this facility:
1. Safely store used lead-acid batteries? Y N
2. Recycle spent lead-acid batteries? Y N
3. Store used antifreeze in structurally-sound, clearly-marked containers? Y N
4. Recycle used antifreeze? Y N

Section 8: Vehicle Washing (For Car Washing Facilities Only)

1. Does this facility perform vehicle washing _________outside or ___________inside?
2. If outside, are vehicles washed on an _____________impervious or __________pervious surface?
3. What type of cleaning agent does this facility use? ______________________________
4. Where does runoff from this operation go? ______________________________

Section 9: (For Supermarkets Only)

1. How is excess food waste disposed of? ______________________________
2. How is cooking oil or other material disposed of? ______________________________

Section 10: (For Animal Care Facilities Only)

How is animal waste disposed of? ______________________________

MANCHESTER URBAN PONDS RESTORATION PROGRAM SURVEY

Dear Resident of Manchester:

This survey is designed to provide a better understanding of the public awareness level concerning the environmental conditions of several urban ponds in Manchester, and also how people feel about the ponds in general. Please take a few minutes to complete this brief survey and be assured that your answers are confidential. For each question please circle the appropriate number that best represents your opinion. When completed, please use the enclosed business reply envelope to return the survey. Thank you, in advance, for taking the time to complete this survey. The input of Manchester residents such as yourself is vital to the success of this research. **Please complete and return the survey as soon as possible.**

Art Grindle - UPRP Coordinator, City of Manchester, NH

PUBLIC AWARENESS

1. Manchester has seven urban ponds, listed below. Please indicate whether or not you know the location for each, and whether or not you have visited each.

	Know Location?		Visited?	
	Yes	No	Yes	No
Crystal Lake	1	2	1	2
Dorrs Pond	1	2	1	2
Maxwell Pond	1	2	1	2
McQuesten Pond	1	2	1	2
Nutts Pond	1	2	1	2
Pine Island Pond	1	2	1	2
Stevens Pond	1	2	1	2

2. Had you heard of the Urban Ponds Restoration Program prior to this questionnaire?

1 Yes 2 No

3. Do you know what a "watershed" is?

1 Yes 2 No

CURRENT WATERBODY CONDITIONS

4. How would you describe the condition of Manchester's urban ponds, in general?

Very Polluted	Polluted	Fair	Clean	Pristine	Don't Know
1	2	3	4	5	0

5. Please rate how serious you think each of the following issues are concerning these ponds.

	Not Serious	Somewhat Serious	Very Serious	Don't Know
Algae/aquatic plants	1	2	3	0
Erosion	1	2	3	0
Illegal dumping/litter	1	2	3	0
Increased development	1	2	3	0
Invasive plant species	1	2	3	0
Habitat destruction	1	2	3	0
Heavy metals	1	2	3	0
Poor recreational opportunities	1	2	3	0
Water level	1	2	3	0
Unsafe neighborhoods	1	2	3	0
Urban runoff	1	2	3	0

FUNCTIONS AND VALUES

6. How valuable do you think the ponds are for wildlife?

Very Valuable	Somewhat Valuable	Neutral	Not Very Valuable	Not At All Valuable	Don't Know
1	2	3	4	5	0

7. How valuable do you think the ponds are for recreation?

Very Valuable	Somewhat Valuable	Neutral	Not Very Valuable	Not At All Valuable	Don't Know
1	2	3	4	5	0

8. Have you engaged in any of the following recreational activities at any of Manchester's urban ponds in the past year?

	Crystal Lake	Dorrs Pond	Maxwell Pond	McQuesten Pond	Nutts Pond	Pine Island Pond	Stevens Pond	Don't Do This Activity
Bird watching	1	2	3	4	5	6	7	0
Canoe/kayak	1	2	3	4	5	6	7	0
Fishing	1	2	3	4	5	6	7	0
Picnic	1	2	3	4	5	6	7	0
Swimming	1	2	3	4	5	6	7	0
Walk/jog the trails	1	2	3	4	5	6	7	0
Other – *Please specify:* ____________	1	2	3	4	5	6	7	

POSSIBLE SOLUTIONS

9. How useful do you think each of the following possible solutions would be in addressing the issues facing Manchester's urban ponds?

	Not Useful	Somewhat Useful	Very Useful	Don't Know
Restrictions on new development near ponds	1	2	3	0
Treating or eliminating urban run-off	1	2	3	0
Restricting public access	1	2	3	0
Volunteer conservation efforts	1	2	3	0
Altering wildlife habitat	1	2	3	0
Chemical treatments	1	2	3	0
Other – *Please specify:* ____________	1	2	3	

10. How interested would you be in volunteering for the following possible events or activities?

	Not Interested	Somewhat Interested	Very Interested	Not Sure/ Need Info.
Litter clean-up events	1	2	3	0
Water quality monitoring	1	2	3	0
Outreach/education efforts	1	2	3	0
Conservation project work	1	2	3	0
Other – *Please specify:* ____________	1	2	3	

DEMOGRAPHICS

11. How many years have you lived in Manchester?

__________ years

12. What ward do you live in?

__________ (1 through 12)

13. Which of the following includes your age?

18 - 29	30 - 39	40 - 59	60 or older
1	2	3	4

14. What is the highest level of education you have completed? (Please circle one only.)

1 Some high school
2 Graduated high school
3 Some college
4 Bachelor's degree
5 Advanced degree

Thank you for your participation!

If you would like further information, please contact Art Grindle (Program Coordinator) at 624-6450 or agrindle@ci.manchester.nh.us

To be placed on the Urban Ponds Restoration Program mailing list, please fill out the information below:

Name: ____________________

Street: ____________________

Phone: ____________________

Email: ____________________

Pond Possibilities

Volume 3, Issue 1 **Summer 2002**

The Newsletter of the Manchester Urban Ponds Restoration Project

Second Annual Manchester Earth & Pond Festival Held at Livingston Park

On Saturday June 22, the Manchester Urban Ponds Restoration Program (UPRP), Manchester Conservation Commission, and Manchester Recycling Program sponsored the city's 2nd Annual Earth and Pond Festival.

Despite the threatening weather, approximately 200 people attended the event to learn about Manchester's urban ponds and a myriad of other environmental issues. Manchester has seven urban ponds which are the focus of the Urban Ponds Restoration Program. These unique ponds provide various uses for Manchester, including boating, swimming, fishing, birding and valuable wildlife habitat. Some other issues addressed by event organizers were alternative energy, non-point source pollution, invasive exotic species, and recycling.

Many environmental organizations were represented at the festival. The Crystal Lake Preservation Association, Dorrs Pond Preservation Society, NH DES, US EPA, Manchester Water Works, Manchester Recycling Program, and Amoskeag Fishways among others were all present and provided information on environmental programs.

As the rain began, so did guided trail walks around Dorrs Pond. Participants learned a lot about pond-side ecology even though they got very wet. Jen Drociak of the Manchester Conservation Commission led the trail walk and pointed out the area's native and exotic plant life. Other activities included face painting, henna body art, balloon sculptures and clowning around with Patches the Clown. Live entertainment was provided by the Buskers, a bluegrass band from New Hampton, NH. The performance had to be cut short due to heavy rain.

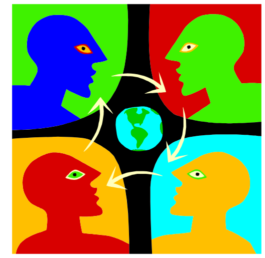
Raffle drawings were held by US EPA and the UPRP with the grand prize being a kayak provided by All Outdoors of Manchester. Other prizes were donated by C.R. Sparks, MS Mount Washington, Jane & the Beanstalk, Fratello's, Cactus Jack's/T-Bones, The Puritan, Outback Steakhouse, and Chalifour's.

INSIDE THIS ISSUE

Suzanne, Andrew and Harry Ntapalis enjoy the sun at the Pond Festival wearing t-shirts bearing Andrew's (age 10) design.

Pond Projects are Prioritized

By: Jen Drociak, Manchester Conservation Commission



Earlier this year, members of the Manchester Conservation Commission met with the Urban Ponds Restoration Coordinator to discuss pond project "prioritization" within the city. Each of the seven ponds was discussed at length with regards to potential water quality improvements, outreach/education opportunities, recreational opportunities, land preservation opportunities, and other management tasks. The result is a clearly defined set of goals and prioritized projects within each of the aforementioned categories. The following is a summary of proposed and prioritized projects at each pond. Please be advised that the following summary is only a list of ideas generated from several brainstorming sessions. Though an attempt will be made to implement the most important projects, not all projects will be implemented.

Crystal Lake

- **Goal(s):** To maintain swimmable/fishable water quality standards.
- **Water Quality Improvements:** (1) Beach parking lot runoff/drainage improvements. (2) Chemical & mechanical control of *Phragmites*. (3) Corning Road runoff/drainage improvements.
- **Outreach/Education Opportunities:** (1) Shoreline planting workshop. (2) *Phragmites* education. (3) Milfoil prevention.
- **Recreational Opportunities:** (1) Beach use enhancement.
- **Land Preservation Opportunities:** (1) Land acquisition in watershed.
- **Other:** Develop a comprehensive watershed management plan.

Dorrs Pond

- **Goal(s):** To restore fishable/swimmable water quality standards.
- **Water Quality Improvements:** (1) Tributary II runoff/drainage improvements. (2) Tributary III runoff/drainage improvements. (3) Wetland function study in the north end.
- **Outreach/Education Opportunities:** (1) Duck feeding. (2) Invasive species. (3) Fertilizer & home actions.
- **Recreational Opportunities:** (1) Parks & Recreation trail improvement project. parkland on west side and possibly designate as "Town Forest."

McQuesten Pond

View of Crystal Lake, Courtesy A. Grindle

- **Goal(s):** To secure conservation easements/ownership of prime wetland areas.
- **Water Quality Improvements:** (1) Pavement reduction. (2) Shoreline restoration.
- **Outreach/Education Opportunities:** (1) Build kiosk. (2) Invasive species. (3) Dumpster & parking lot runoff.
- **Recreational Opportunities:** (1) Boardwalk at north end.
- **Land Preservation Opportunities:** (1) Secure conservation easements.

Maxwell Pond

- **Goal(s):** To assess feasibility of dam removal. To assess habitat enhancement.
- **Water Quality Improvements:** (1) Dam removal study. (2) Upstream sedimentation of Black Brook. (3) Manchester Gardens apartment complex runoff/drainage improvements.
- **Outreach/Education Opportunities:** (1) Build kiosk. (2) Calvary Cemetery yard waste. (3) Invasive Species.
- **Recreational Opportunities:** (1) Create car-top boat-launch. (2) Park improvements.
- **Land Preservation Opportunities:** (1) Secure parkland. (2) Research easements and zoning.

Nutts Pond

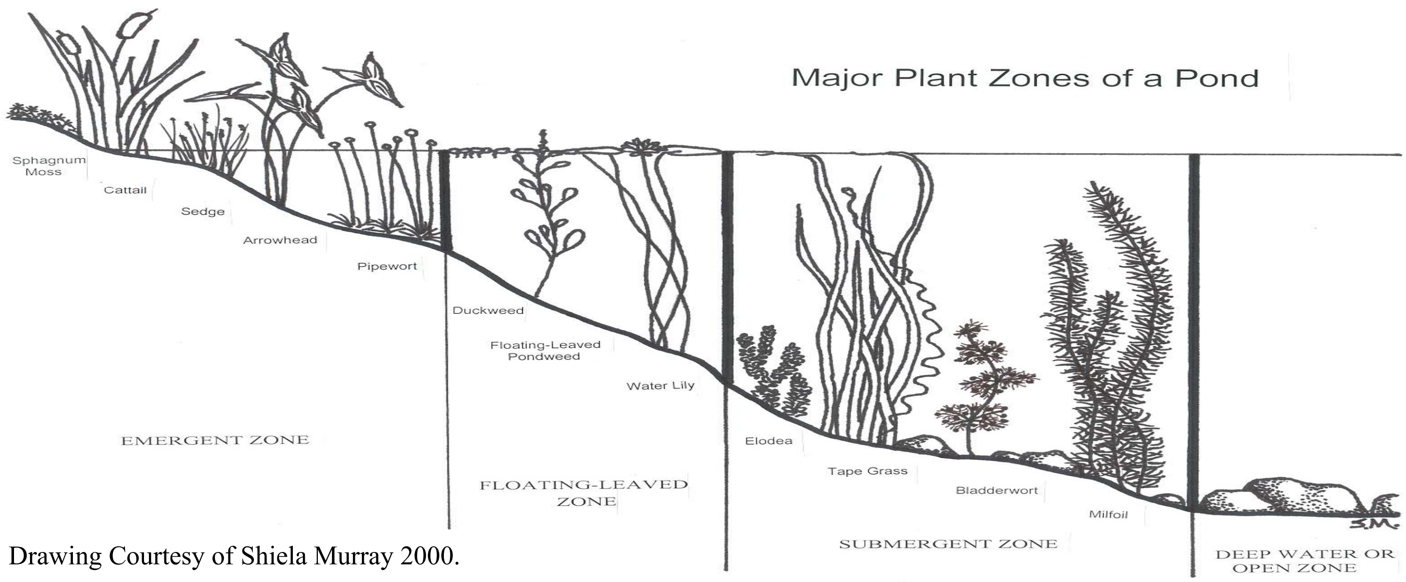
- **Goal(s):** To improve sport fishing and non-motorized/recreational boating opportunities. To improve water quality.
- **Water Quality Improvements:** (1) Drainage study of four urban runoff outfalls. (2) Dredging near outfalls. (3) Shoreline stabilization.
- **Outreach/Education Opportunities:** (1) South Willow Street commercial lot maintenance. (2) Invasive species/Brazillian waterweed management. ***Continued on Page 5.***

Pickerelweed, Waterlilies, & Bladderwort: A Guide To What's Growing In Your Pond

By: Jen Drociak, Manchester Conservation Commission

Herbaceous (non-woody) freshwater plants are categorized according to their position relative to the water. Below is a description of each of the "zones" and the plants that inhabit them.

- **Emergent Plants:** (such as cattail, pickerelweed, arrowhead, rushes, and sedges) grow close to the shore and are rooted in muddy soil and shallow water. Exotic invasive species such as purple loosestrife and common reed are also emergent plants and compete with more beneficial natives such as cattails and rushes.
- **Floating-Leaf Plants:** (such as yellow pond lily, white water lily, floating heart, and watershield) are rooted underwater. Their flexible, air-filled stems support broad leaves that float on the surface. Since the stems may be several feet long, these plants survive in deeper water than emergent plants.
- **Submergent Plants:** (such as bladderwort, coontail, waterweed, and pondweeds) have feathery leaves and grow completely underwater. They can grow in deeper water if it is clear enough for light to penetrate.



Drawing Courtesy of Shiela Murray 2000.

Note: There is an exotic, invasive submerged plant (brazillian elodea) currently infesting Nutts Pond. The infestation was discovered and documented during the summer of 2001. A study is being performed by the Department of Environmental Services, and management options will be addressed with the Conservation Commission. If you are recreating at this waterbody, please be sure to check boat trailers, outboard engines, and fishing gear for plant fragments, and leave them there! This is the only waterbody where this plant has been documented, and brazillian elodea has the potential to be more invasive than variable milfoil (which currently infests over 50 waterbodies in NH). Submerged exotic vegetation can make fishing, swimming, and boating difficult, if not impossible, and can severely alter the native ecosystem.

Comprehensive Environmental Inc. Contracted to Design Pond Projects

By: Art Grindle, Urban Ponds Restoration Coordinator

Comprehensive Environmental Inc. of Merrimack, NH has been awarded a contract to complete design work for several conservation projects on Manchester's urban ponds. The projects are intended to reduce the pollutant load entering our water bodies by installing what are known as Best Management Practices (BMP's) at key locations. Some examples of BMP's are settling basins and infiltration swales.

These projects will reduce non-point source pollution from roads, parking areas and other areas by capturing these pollutants (phosphorus, nitrogen, bacteria, etc.) and encouraging vegetative uptake. Phase 1 of the contract will include designs for sites at Dorrs Pond, Crystal Lake, and studies at Nutts and Stevens Ponds.

Comprehensive Environmental Inc. was chosen by the UPRP for their innovative, "soft-engineering" approach to environmental problems. Eileen Pannatier, President, and her staff have been working on environmental engineering projects in New England for fifteen years.

Continued from Page 2.

- **Recreational Opportunities:** (1) Pond circuit trail/Rails-To-Trails project. (2) Boat ramp improvements.
- **Other:** Possible future Diagnostic/Feasibility Study in collaboration with the DES.

Pine Island Pond

- **Goal(s):** To maintain fishable/swimmable water quality standards. To improve fish habitat.
- **Water Quality Improvements:** (1) Assess sedimentation at north-end inlet. (2) Assess accelerated plant growth. (3) Implement streambank stabilization efforts at Cohas Brook.
- **Outreach/Education Opportunities:** (1) Aquatic plants. (2) Invasive Species. (3) Boating. (4) Fertilizer & home actions.
- **Recreational Opportunities:** (1) Fish passage at dam.
- **Other:** Develop a comprehensive watershed

Stevens Pond

- **Goal(s):** To improve water quality through a partnership with the Department of Transportation.
- **Water Quality Improvements:** (1) Improve I-93 runoff. (2) Assess erosion at headwaters.
- **Outreach/Education Opportunities:** (1) Build kiosk. (2) Invasive species.
- **Recreational Opportunities:** (1) Boat launch improvements. (2) Wetland boardwalk/trail creation & improvement.
- **Land Preservation Opportunities:** (1) Secure adjacent parkland.

Meet Your Pond Events!

Do you see Manchester's urban ponds as life-less or "dead"? The truth is, they are abundant with life! Join the Urban Ponds Restoration Coordinator and members of the conservation commission for a meet your pond adventure. Walk the trails, investigate native and exotic vegetation and wildlife, and see how to sample water for chemical and biological parameters.

Throughout the summer Meet your Pond days have been occurring at all of Manchester's ponds. The final Meet your Pond day will be held at **McQuesten Pond** on **August 15th**. The pond activities are from **9:00-noon** and will commence at **Wolfe Park**.

Dress accordingly and come Meet your Pond!

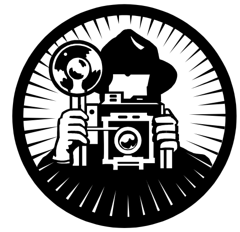
An environmental consulting firm has recently been contracted to begin the design phase of several of these projects. Comprehensive Environmental (CEI) will begin working on the following projects:

- Final design for tributary II runoff/drainage improvements at Dorrs Pond.
- Final design for tributary II runoff/drainage improvements at Dorrs Pond.
- Final design for Crystal Lake beach drainage improvements.
- Final design for Corning Road drainage improvements at Crystal Lake.
- North-end drainage analysis (including total phosphorus modeling for subwatersheds) at Nutts Pond.
- I-93 chloride loading study proposal preparation for Stevens Pond.

For more information on any of these projects, please contact the Urban Ponds Restoration Coordinator at (603) 624-6450 or agrindle@ci.manchester.nh.us.

Tributary II East at Dorrs Pond: A source of pollution to the pond. Photo, A. Grindle.

Give Us Your Best Shot!



<u>Photo Contest Deadline: October 1, 2002</u>

Don't forget your camera while you're out enjoying your watershed this summer and fall! Photos must be taken at one of the seven Manchester urban ponds and the categories are **Nature/Scenic** and **People Enjoying the Watershed**. You can submit up to two photos in each category. Entries must be unmounted prints, 5" x 7" or larger. Winning photographs will be printed in the UPRP newsletter and posted at urban pond kiosks.

<u>UPRP PHOTO CONTEST</u>

Name: ______________________________ Address: ____

Phone: ______________________________ E-Mail: ____

Photo Title (optional):____

Specific Photo Location (required): ____________________________Date of Photo: ______________

Why is this place or photo special to you? ____

____

____

I understand that the UPRP cannot be responsible for loss or damage to photos. No rights to this photo are held by any other person, business, or organization. I own and will retain photo rights, but agree that the UPRP may freely publish and publicly display this photo, with credit to me, for various publicity purposes.

Urban Ponds Restoration Program
One City Hall Plaza
Planning Department
Manchester, NH 03101

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Appendix B
Newspaper Articles Relevant to the UPRP

Appendix C
Glossary

Acid Neutralizing Capacity - Acid Neutralizing Capacity (ANC) describes the ability of water to buffer against acidic inputs, such as acid rain. This is also known as a lake's alkalinity. The higher a water body's ANC, the better it's ability to buffer acidic inputs. Lakes with low ANC, typical of New Hampshire, are especially vulnerable to the effects of acid precipitation.

A desirable ANC for any lake is greater than 20 mg/L of Calcium carbonate (CaCO). The average ANC for New Hampshire lakes is 6.5 mg/L. (NHDES, 1999.) The average ANC for Manchester's ponds is 19.5 mg/L.

Chlorophyll-*a* - **Chlorophyll-*a*** - The concentration of chlorophyll-a is an indicator of algal abundance. Because of the presence of chlorophyll-a pigment in algae, the relative concentration of chlorophyll-a in the water gives an indication of the concentration of algae. As the alga population increases, so does the chlorophyll-a concentration.

Chlorophyll-*a* concentrations greater than 10.0 mg/m^3 usually indicate an algal bloom. The mean chlorophyll-*a* value for New Hampshire lakes is 7.47 mg/m^3. (NHDES, 1999.) The mean chlorophyll-*a* concentration for Manchester's ponds is 9.36 mg/m^3.

Similar to the summer of 2001, the summer of 2002 was filled with many warm and sunny days and there was a lower than normal amount of rainfall during the latter-half of the summer. The combination of these factors resulted in relatively warm surface waters throughout the state. The lack of fresh water input to the lakes/ponds reduced the rate of flushing which may have resulted in water stagnation. Due to these conditions, many lakes and ponds experienced increased algae growth, including filamentous green algae (the billowy clouds of green algae typically seen floating near shore), and some lakes/ponds experienced nuisance cyanobacteria (blue-green algae) blooms.

Conductivity - Conductivity, also known as specific conductance, is a measure of the ability of water to conduct an electric current. This is determined by the number of ionic particles present in the water. High conductivity values may be indicative of non-point source pollution (i.e. polluted runoff), but may be affected even more dramatically by natural geologic features of the watershed.

Conductivity values for New Hampshire lakes that are greater than 100 micro Mhos (uMhos) are most likely indicative of anthropogenic sources of excess ions in the water, since the average conductivity for New Hampshire lakes is 56.8 uMhos. Anthropogenic sources include urban runoff (metals from cars, sodium from road salt), and agricultural runoff (sediment from erosion, phosphorus from fertilizers and animal wastes). (NHDES, 1999.) The average conductivity for Manchester's ponds (epilimnion or upper layer) is 611.9 uMhos.

Typically, sources of increased conductivity are due to human activity. These activities include septic systems that fail and leak leachate into the groundwater (and eventually into the tributaries and the lake/pond), agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron deposits in bedrock, can influence conductivity. It is possible that the lower than normal amount rainfall during the latter-half of the summer reduced tributary and lake flushing, which allowed pollutants and ions to build up and resulted in elevated conductivity levels.

Dissolved Oxygen (DO) - Dissolved oxygen levels are key to the health of a pond ecosystem. Fish and other aquatic organisms need dissolved oxygen to breathe. At colder temperatures, water holds more oxygen than at warmer temperatures. Bacteria and other pollutants can also "use up" dissolved oxygen, through decomposition, the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter). Thus, summer dissolved oxygen concentrations are typically lower than those collected in cooler months, and deeper readings are higher than more shallow readings

A dissolved oxygen and temperature profile is determined by measuring DO and temperature at each meter of depth from the water's surface to the pond bottom. Pond stratification occurs when different temperatures exist at the top (epilimnion), middle (metalimnion), and bottom (hypolimnion) layers of the water column. Generally, the deeper a body of water, the more pronounced the stratification may become. This is mainly influenced by the amount of solar energy that reaches each water layer. As the sun becomes lower in the sky in the fall, thermal stratification lessens and usually disappears completely by winter. Deeper ponds experience pronounced thermal stratification, while in shallower ponds stratification is subtler, if present at all. Due to biological processes that consume oxygen at the pond bottom, some ponds incur a dissolved oxygen deficit in the hypolimnion (bottom layer).

"Typically, the deeper the reading, the lower the percent saturation of oxygen. Colder waters are generally able to hold more dissolved oxygen than warmer waters, and generally, the deeper the water, the colder the temperature. As a result, a reading of 9 milligrams/Liter (mg/L) of oxygen at the surface will yield a higher percent saturation than a reading of 9 mg/L at 25 meters, because of the difference in water temperature." (NH DES, 1999).

Epilimnion (Epilimnetic) – Top layers of a lake (having to do with the top layers of a lake).

Hypolimnion (Hypolimnetic) – Bottom layers of a lake (having to do with the bottom layers of a lake).

Mean – The value directly in the middle. The value for which there are equal values above and below. For instance, the mean Chlorophyll a concentration for NH lakes is the concentration for which there is an equal number of lakes with greater concentration and lakes with a lower concentration.

Metalimnion (Metalimnetic) – Middle layers of a lake (having to do with the middle layers of a lake).

pH - The lower the pH of water, the more acidic the water. The higher the pH of water, the more alkaline the water. Pond pH is crucial to the well being of pond dwelling organisms. A pH of less than 5.5 (acidic) has detrimental effects on fish growth and reproduction. A pH between 6.5 and 7.0 is considered ideal for freshwater ecosystems. The median pH for New Hampshire lakes is 6.7. (NHDES, 1999). The median pH for Manchester's ponds is 7.07.

Phosphorus - Phosphorus is a necessary nutrient for plant and algae growth. It is generally "limiting" in New Hampshire waters, meaning that plants have plenty of everything else, and only the amount of phosphorus present keeps their growth in check. Too much phosphorus in a lake/pond can therefore lead to unhealthy increases in plant and algal growth. The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 11 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.

Phosphorus exists as a natural element, but becomes a problem when inputs from such sources as septic systems, erosion, animal wastes, and fertilizer load the water body with excess amounts. One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

Secchi Disk Transparency - A Secchi disk measures the depth that one can see into the water, and so the depth that sunlight can reach into the water. Although a low Secchi disk transparency is not necessarily "bad", a change in transparency over time is undesirable, because it may cause plants and animals currently living in the pond to die off or may cause a change in the pond life diversity. To measure Secchi disk transparency, a black and white patterned disk is lowered into the water, and the depth at which it is no longer visible is recorded. This indicates water clarity, which is affected by the amount of algae and particulate matter (turbidity) in the water column. Secchi disk readings are somewhat subjective, but generally correlate with chlorophyll-*a* concentrations and turbidity levels.

The mean transparency for New Hampshire lakes is 3.7 meters. (NHDES, 1999.) The mean transparency for Manchester's ponds is 2.1 meters. If we assume that Manchester's ponds were originally more typical of New Hampshire lakes, then we would estimate that they are more "cloudy" than they should be. Steps to decrease turbidity and increase transparency/clarity (i.e. reducing polluted runoff entering the ponds, and stabilizing banks) are therefore being planned.

Two different weather-related patterns occurred during the spring and summer of 2002 that influenced lake quality during the summer season. In late May and early June, numerous rainstorms occurred. Stormwater runoff associated with these rainstorms may have increased phosphorus loading, and the amount of soil particles washed into waterbodies throughout the state. Some lakes and ponds experienced lower than typical transparency readings during late May and early June.

However, similar to the 2001 sampling season, the lower than average amount of rainfall and the warmer temperatures during the latter-half of the summer resulted in a few lakes/ponds reporting their greatest-ever Secchi-disk readings in July and August (a time when we often observe reduced clarity due to increased algal growth)!

Typically, high intensity rainfall causes erosion of sediments into lakes/ponds and streams, thus decreasing transparency and clarity. Efforts should continually be made to stabilize stream banks, lake/pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake/pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from NHDES upon request

Turbidity - Turbidity is a measure of suspended matter in the water. The more material (clay, silt, algae) suspended in the water, the higher the turbidity. These materials cause light to be scattered and absorbed, instead of transmitted in straight lines, leading to decreased water transparency/clarity. High turbidity readings are often found in water adjacent to construction sites, or waters otherwise polluted. (NHDES, 1999.)

The median turbidity for New Hampshire lakes is 1.0 NTU. (NHDES, 1999.) The median turbidity for Manchester's ponds is 1.55 NTU.